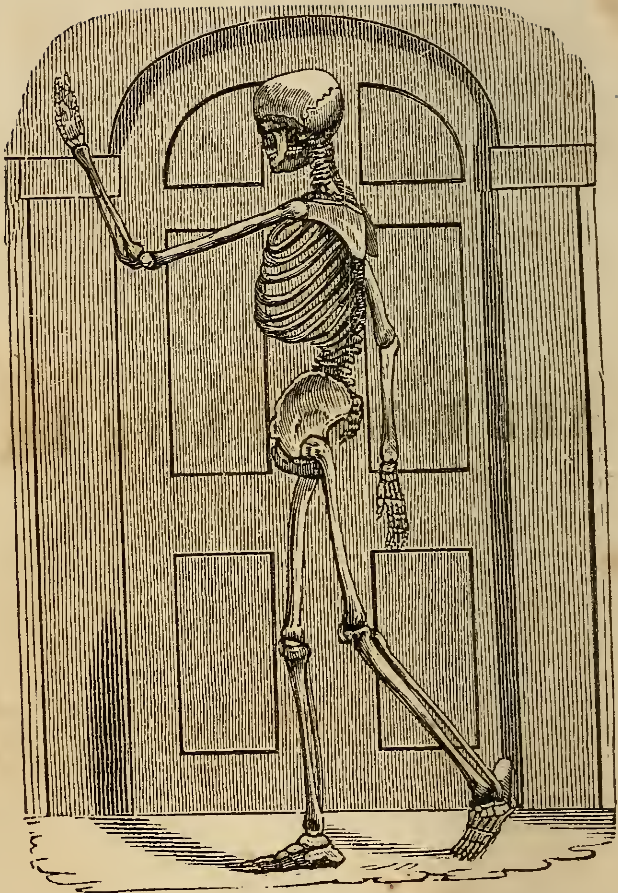
THE HOUSE I LIVE IN.



"I am fearfully and wonderfully made!"

THE

HOUSE I LIVE IN:

OR

THE HUMAN BODY.

FOR THE USE OF FAMILIES AND SCHOOLS.

BY DR. WM. A. ALCOTT,
Author of the Young Woman's Guide, Young Husband,
Young Wife, Young Mother, &c. &c.

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ADVERTISEMENT

TO THE THIRD EDITION.

This work has now been revised, probably for the last time. Its author will not probably ever be able—from the nature of the case—to render it much more perfect. In the present revised edition, he has freely availed himself of the suggestions of Mr. Girtin, a British surgeon, who has recently prepared an edition of the work for the children of both sexes in the schools of England;—some of whose improvements are truly valuable. He has also profited, as he trusts, from the suggestions of several medical gentlemen on this side of the Atlantic.

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Under these circumstances, it is impossible for the author to avoid indulging the hope, that if the opinion of Dr. Reynolds, a distinguished physician and surgeon of this city, as expressed in a letter received from him sometime since, be correct, that the "House I live in" ought to be studied not only in our week day schools, but in our Sunday schools, it will so far receive the confidence of teachers and parents, as to render it a text book in all our common schools, introductory to the larger and more costly works of other writers.

Boston, December, 1838.

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PREFACE.

The study of the human frame has usually been confined to the members of the medical profession. But wherefore? Why should not a subject which so nearly concerns us all, engage the attention of others, as well as of surgeons and physicians? Do we not carry about with us, through life, a machine so ingeniously constructed that, in view of it, even an inspired writer exclaimed, "I am fearfully and wonderfully made?"

Our minds, moreover, are the tenants of bodies so constructed as to be continually liable to waste, as well as to become disordered; and yet we are neither taught the way to keep them in order, nor to prevent them from premature decay. These bodies act also

upon our minds in a wonderful manner; for if anything in the body is wrong, it affects either our thoughts or our feelings, or both.

To keep the mind and heart right, therefore, we should know how to keep the body right. Who understands this? What persons, except medical men, as I said before, ever study their bodies? Is it not strange that knowledge of such vast importance should have been so long overlooked, and practically disregarded?

There are reasons, however, for all this neglect. Many connect with the thoughts of studying the human frame, the idea of skeletons, dead bodies, knives, dissections, disinterments, and violent deaths. No wonder the mind should revolt at so horrible a picture. No wonder that Anatomy and Physiology—for these are the hard names given to the study of the body and the laws of the body—should be neglected and despised, if these things are inseparable from it!

But they are not so. Both anatomy and physiology may be studied with some advantage, without the dissecting knife. Much may be learned with the aid of nothing but a book and a few good engravings; and in fact without either of these. The body itself may be studied; this is always at hand. And if dissections are even made, portions of birds or quadrupeds may be obtained, which will partly answer the purpose. The heart, for example, of most of the common domestic animals, nearly resembles the heart of man, and would answer every purpose. All good citizens disapprove of every form of disrespect for the bodies of the dead; and above all, the barbarous practice of robbing graves.

Still, this subject must be studied. Man, as has just been observed, has a body as well as a mind. A system of education which overlooks either is essentially defective.

It was in this view that the author commenced a series of essays on anatomy and

physiology, in the first volume of the Juvenile Rambler. They were continued into Vol. 2 of the same periodical, and also into Vols. 2, 3 and 4 of Parley's Magazine. Many of them were written under the title of the "House I live in." The favorable reception they met with, and the solicitations of parents and teachers, together with an increasing conviction of the absolute necessity of something of the kind, have induced him to go further, and prepare a work for families and schools.

But he wishes it to be distinctly understood, that he does not intend this as a substitute for any known work. The information which it gives, in anatomy and physiology, would, indeed, be of great value, without the study of other works. But it is chiefly intended to introduce the young to such works as Smith's "Class Book of Anatomy," and Hayward's "Outlines of Physiology;" and if its adoption in part as a reading book, and in part as a class book, in our schools, should smooth or

pave the way to the use of those more complete works, the writer would not regret its publication.

He looks forward to the period as not very distant, when a knowledge of the physical nature of man will be as generally taught to every individual of the whole race, as arithmetic and geography now are; and will be as universally found in our schools. And he cannot but fondly hope to remove a little of the repugnance which many feel to this study, by the peculiar manner in which he has here presented it.

The general plan of the work is something more than mere theory. It has been tested by experiment, both in school and elsewhere; and with the most complete success.

There is one more hope that the author indulges, in the publication of this volume. It is, that it will have a good tendency on morals. Still more than all this. Besides having the favorable tendency which physi-

ology must have on human happiness generally, the writer believes that no branch of natural science is more likely to induce us to look "through Nature up to Nature's God."

Boston, January, 1837.

THE HOUSE I LIVE IN.

CHAPTER I.

GENERAL REMARKS.

Size of the house. Its age—beauty—cost—rooms—occupants—furniture.

"The house I live in" is a curious building; one of the most curious in the world. Not that it is the largest, or the oldest, or the most beautiful, or the most costly; or that it has the greatest number of rooms or occupants, or the most fashionable furniture. Still it is one of the most wonderful buildings in the world, on account of the skill and wisdom of the great Master Workman who planned it. You can hardly view it closely in any part, without being struck with the wisdom which is shown, or without having your minds ele-

vated and improved by the contemplation of that Divine Goodness, which has so admirably adapted everything to the purpose it was intended to fulfil.

Size of the House.—I said that it is not the largest building in the world. Very far indeed from that. There are very many buildings—castles and palaces, churches and cathedrals, mansions and factories—which are thousands, tens of thousands, nay, hundreds of thousands of times larger than the House I live in; indeed it can hardly be said that in any country, barbarous or civilized, there is to be found a single human dwelling place, from the hut of the savage to the palace of the king, but what occupies a far greater space than the house I am about to describe.

The mosque of Omar, at Jerusalem, for example, which, according to travellers, is 1489 feet (more than a quarter of a mile) long, and 995 feet wide, covering forty-one acres, is of course thousands of times as large. The palace and church of the Escurial in Madrid, in Spain, is nearly a mile in circumference. The great tobacco factory at Seville, in Spain, covers

about seventeen acres, and is also thousands of times as large as my house is. So are also St. Peter's Church at Rome, and St. Paul's in London; the latter of which covers six acres. Even the City Hall in New York, which is only 216 feet long and 105 broad, is many thousand times as large. In truth, the house I live in is of very limited extent in any direction; for though it may be said to have two stories, and a cupola or dome, yet the whole seldom towers beyond the height of six feet.

Its Age.—It is not the oldest building in the world. The pyramids of Egypt, erected 3000 years ago, are proud monuments of the architectural skill of the designers; and even now seem to defy the hand of time. The sepulchral monuments lately discovered in Etruria; the splendid temples and other sacred edifices at Athens; the gigantic ruins of Palmyra, Luxor and Karnac; the immense and curiously constructed caverns of Elephanta, can all boast a high antiquity. Many churches and palaces, though with far less pretensions to age than the structures I have named, have existed several hundred years.

A traveller assures me that he once saw a house in Nantes, in France, in which Julius Cæsar slept at the time of his passing through France to invade Great Britain; which you know is almost two thousand years ago. Buildings of brick and stone several hundred years old are very common in Europe. They are, of course, less so here, because it is little more than 200 years since our ancestors came over here, and began to drive away the savages and erect dwellings. Yet even here you will occasionally find a house nearly 200 years old. There are some *wooden* houses, both in Boston and its vicinity, which are almost 200 years old. But the building about which I am going to tell you, has not yet stood half a century; and with the utmost attention and care could not probably be made to last a century.

Its Beauty.—The house I live in is not the most beautiful in the world. It is not indeed without beauty; but it would poorly compare with the elegant temple of Solomon, in the days of its greatest glory; or even with the Arcade of Providence, the Massachusetts

Hospital in Boston, or the Capitol at Washington. Some, it is true, undertake to say it is a great deal more beautiful than any of these; but on this point I leave you to form your own opinion, after I have told you more about it.

Its Expense.—Nor is it the most costly. Many a building has cost its millions of dollars. The Capitol at Washington cost two millions of dollars, and even the City Hall in New York half a million. The Seville tobacco factory, in Spain, cost six millions. Some European palaces, cathedrals and other edifices, probably cost a dozen or twenty millions. The house I live in, meanwhile, may be said to have scarcely cost me anything; for it was found ready to my hand. The necessary expenses of keeping it in repair are but small, when the simple intentions of nature respecting it are all fulfilled.

Rooms.—Nor does it contain the greatest number of rooms that I have ever known in a building, though it may be said to contain a large number for so small a place. Perhaps there may be fifteen or twenty. Whereas

many public buildings contain a number much greater—sometimes several hundred.

Occupants.—As to the number of occupants, it will hardly bear a comparison with any known building; for, like some of the huts of the rude tribes of New Holland, it never accommodates more than one person—and that one is myself.

But even with the rude huts of the New Hollanders, the comparison, as I have said, will not hold good. They are made of the bark of a single tree, bent in the middle, and placed with its two ends on the ground. When one of the natives has taken up his abode in a hut of this kind as long as he has seen fit, he leaves it. He journeys to another place, and builds a new one, and the old hut is taken possession of by any who choose. Whereas I always carry my house with me wherever I go. In all countries, in all climates, in all seasons, my house is ready for my use. The house I live in is good for nothing at all, however, for any one but myself; and when I leave it, it will immediately fall into decay.

Furniture.—The furniture of the house I live in is not of the most fashionable appearance. Of this the reader can judge for himself, when he understands that it has been the same in kind for nearly forty years.

The fashions, you know, in everything, are continually varying; and what appears well now, will, by another year, be considered awkward or deformed. But the furniture of my house, being from the very first most admirably adapted to the wants of its occupant, does not require, from year to year, the slightest attention, on my part; that is, by any direct effort.

In Siam, the houses are frequently built on posts or pillars. This is because the country is low, and apt to be overflowed every year by the rivers; and to build on high posts is the only way to secure themselves against these floods. In Venice also, and Amsterdam, the buildings are erected upon piles, to elevate and protect them from the inroads of the sea. My house, as you will see hereafter, stands on pillars, but these pillars were made for motion, that the building may be transported to any place desired. Whereas an Amsterdam or

Venetian house cannot be removed at all; nor a Siamese house without considerable injury.

The house I live in is, after all, most remarkable for its convenience. Nothing could possibly so well answer my purpose. I have already told you that it would be good for nothing for any other person. Your house, young reader, may be as beautiful, as curious, as large, and even as commodious for you, as mine is for me; but it would never answer my purpose at all, even if I had it in my power to exchange with you.

In the progress of the following chapters, I shall give you many more particulars. I shall describe to you, in the best way I can, the FRAME, the COVERING, the APARTMENTS, the FURNITURE and the EMPLOYMENTS of the House I live in; and shall give you, briefly, an account of the structure, uses and abuses of each. I have endeavored to avoid difficult words, as much as possible; and of the few which occur, I have given a brief explanation at the end of the volume.

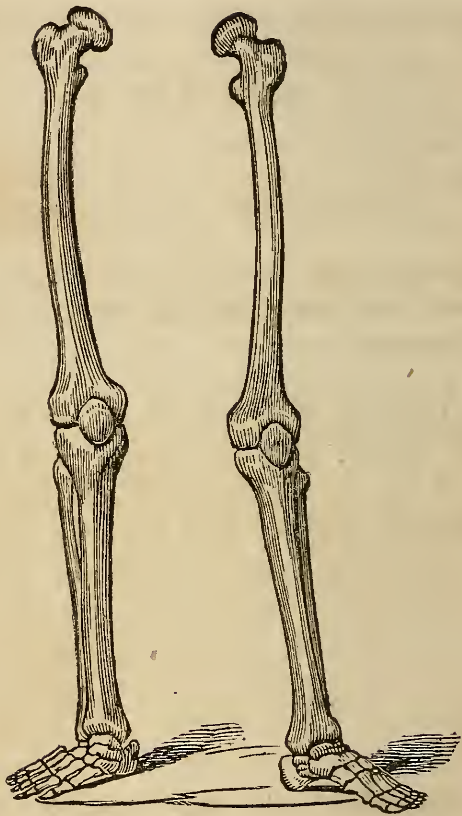
CHAPTER II.

FRAME-WORK OF THE HOUSE.

The thigh bone. The leg. The knee pan. The foot. The arch of the foot. Proof of contrivance. The ankle.

A SINGLE glance at the picture which you see opposite the title page, will at once unravel all the mysteries of the last chapter. You will discover that the house I live in is my body—the present habitation of my immortal spirit. You will also discover that the frame-work of my house consists entirely of bones. These I am now going on to describe.

THE PILLARS.—The pillars are the bones of the lower extremities. Standing by themselves, as they do in the next engraving, and detached from all their connections, you will be apt to think they are not well proportioned; but as you see them with the rest of the building, they will appear very differently.



I spoke of the lower extremities of the human frame. These are commonly reckoned in three divisions; the thigh, the leg, and the foot. Besides these, there is the knee pan or patella. Each thigh has one bone, each leg two, and each foot twenty-six.

Besides these—fifty-eight in the whole in both legs—and the two patellas, there are in some people, at the largest joint of the great toe, one or two small bones, having a slight resemblance to the knee pan or patella. They are called sesamoid bones, because they have been supposed to resemble the seeds of the sesamum, a wild eastern plant.

THE THIGH BONE.—The bone of the thigh is called the *femur*. It is the longest bone in the whole human frame. At its upper end, where it is connected with the hip bone, is a round knob or head. This head fits into a corresponding hollow or cavity of that bone, and is fastened there in a way which will be described in another place. These round heads do not appear quite round enough in the opposite engraving; but in all other respects it represents these important parts of the human frame quite correctly.

THE LEG.—The lower end of the femur joins with, or rather rests upon, the large bone of the leg. The leg below the knee consists of *two* bones. The *tibia* (so called because

it resembles a tube or pipe, or as some have imagined, a hautboy) is much the largest. The other is called the *fibula.* They are so placed that the fibula is on the outside. Where the tibia and the femur meet, they form what is called a *hinge joint,* which means a joint that will only allow of motion backwards and forwards in one direction, like a door on hinges. But more of this hereafter.

THE KNEE PAN.—On the fore part of this lower extremity, where the femur meets the tibia and fibula, to form the knee joint, the patella or knee pan is placed. This is a round flat bone, not joined to the other bones, but lying very closely on them, and kept in its place by what are called tendons. You may see a little how this bone looks in the last engraving; but I here present you with a picture of it, on a larger scale.

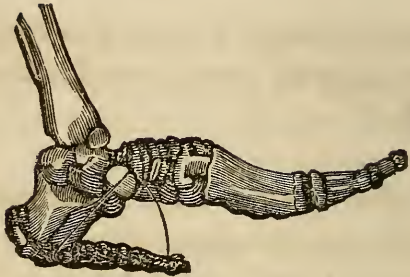
Although this bone might seem at first view almost useless, yet it serves many important

purposes; and there is scarcely a bone in the body but might be spared as well if not better than this.

THE FOOT.—The bones of the foot have a general resemblance to the bones of the hand, which I shall describe fully in another place. But they differ from those of the hand in several important particulars.

The foot is composed of twenty-six little bones, strongly fastened together by gristle, or ligaments. These ligaments yield, when we bear upon the foot, just enough to have it conform to the surfaces on which we tread. If the foot consisted of one solid bone, it would not yield or spring at all; and it would be liable to be broken when we jump or fall on our feet. Think how clumsy a wooden foot would be! And one of solid bone would be almost equally so.

ARCH OF THE FOOT.—The *arching* of the foot is a singular contrivance. It is, really, very much like the arch of a bridge upon its two abutments. I will explain the matter.



In the above engraving, the foot is not placed flat down upon the ground, but in the position which it has when we walk, and are just setting it down. Then, as may be seen by the two lines drawn, it descends in a semicircle from the point of the heel. The lowest extremity of the heel and the ball of the great toe may be considered as the abutments of the arch, while the bones of the instep form the arch itself.

You may easily perceive, by lashing a strip of wood to the bottom of the foot, how awkwardly we should feel if we were obliged to walk with a *flat* foot. It is quite evident there would be no *spring* when we tread on it. We could hardly walk, run, leap or swim at all.

One thing more. The heel is not exactly under the leg, but runs back like a spur, and

is fastened to the main body of the foot by a very firm but springy (elastic) joint. On this account, when we walk, (the heel being thus formed like a spur, and having a great deal of elasticity,) we put it down first, and the whole weight of the body does not come down with a jolt, as it otherwise would do, but more gently.

Its Contrivance.—Taken altogether, the foot is a most admirable contrivance. It is, indeed, arched *both* ways; from the toes to the heel, and from side to side. It will help you to get a clearer idea of this arched structure, to step into the water with your bare foot, and then step immediately upon a dry floor, and find what sort of a track it will make. You see only a spot for the heel, and several spots for the toes and the parts of the foot near them. The middle part of the foot will scarcely touch the floor at all. There is, however, a difference in the form of feet. Some persons have flatter feet than others. All persons, however, have the soles of their feet apparently less arched than is shown by the engraving, on account of the muscles, tendons,

blood vessels, &c., which in a great degree fill up the hollow in the *real* foot.

I have said that this part of the human form is most admirably contrived ; and it is so. When we examine the feet of the camel, the elephant, the horse, the dog, the cat or the bird, we are struck with the wisdom of the Creator, in adapting them to the kind of life they are destined to lead. The foot of the camel is so made, that it does not sink deeply into the sand on which it travels. The horse could not travel much in the deep sands of Arabia, his foot being more elastic, and made for firmer ground. It is, indeed, so very elastic, that those who *shoe* the horse find it necessary to make the shoe as narrow round the edge as possible, so that the iron may not press upon the softer and more elastic part of the foot, inside of the hoof.

The Ankle.—Between the lower ends of the tibia and fibula, and the bones of the foot, are seven short bones, not unlike those of the wrist in shape, but rather larger. Of these you will get a better idea, when I describe the bones of the upper extremities.

CHAPTER III.

MATERIAL OF THE FRAME.

Structure of bone. Shape of the bones. Description of the bones. Growth of the bones. Vessels of the bones.

You have already seen that the frame-work of the house I live in consists chiefly of bone. Before we go any farther, I ought to tell you how bones are constructed, and of what substances they are formed.

Structure of Bone.—Sticks of timber are evidently full of little holes; for if you take a piece of wood, of several kinds which I could mention, and placing your mouth at one extremity, blow hard, you can force a little air through it, from end to end. This shows that there are little holes or tubes running lengthwise, all the way through. If you could blow hard enough, you might force air through any kind of wood. The philosopher and chemist,

by the aid of machinery, will force water and even quicksilver through the pores of almost any sort of wood.

But you cannot blow through any of the timbers of the house I live in. This shows that the internal structure of bone, though in appearance somewhat similar, is very different from that of wood. I will endeavor to show you wherein it is different.

Shape of Bones.—Bones are of three kinds;—*long* bones, *broad* or *flat* bones, and *round* bones. The long bones have a hollow through them, containing marrow or pith; but the other two sorts of bones have no such cavity or hollow. They have, however, a great many little holes or cells in the inside. Some of them look, when broken, almost like sponge or honey-comb. Some of the long bones, besides being hollow, are also spongy. They are generally largest and most spongy at the ends, and smaller and more firm at the middle, with fewer of the little cells.

All the bones in the body are very hard on the outside. Perhaps the teeth are most so. The inside of the teeth is not much harder

than other bones; but the outside is coated with a substance called *enamel*, which is very hard indeed.

Description of the Bones.—You have already been told that the long round bones, such as the humerus and the femur, are hollow, and have marrow in them. This marrow nearly or quite fills up the hollow.* There is a very fine, thin membrane that lines the hollow, and also runs in among the marrow. The same sort of membrane lines also the little cells in the spongy bones. These cells have a small quantity of liquid in them, and none of them appear to be entirely empty.

Most of the bones are pierced through their outside with one or more holes of considerable size, through each of which goes an artery to convey blood to nourish the bones; and a vein comes out by the same passage, to bring back what is not used up. You may wonder that I should talk about blood in the bones.

* This is true of the bones of most other animals besides man. The bones of many birds, however, are entirely hollow, and contain air, to assist them in flying.

But there *is* blood in them, though not a great deal. This blood, with its vessels, the nerves, and the membranous lining, together with the marrow and liquid matter which they contain, amount to many pounds in weight; for after the bones of any animal have been thoroughly dried, and all moisture extracted from them, they become almost twice as light as before. The bones of the whole human frame, when perfectly dry, weigh from eight to twelve pounds.

When they appear perfectly dry, if you burn them in a hot fire for a long time, you will lessen their weight a great deal more; I believe about one half. What burns out, in these cases, is animal substance—principally *gelatine*, or that which makes *glue*. The half which remains is much of it carbonate of lime, or chalk. So that a person carries about with him, every day, a considerable quantity of lime.

The great purpose which the Creator doubtless had in view, in giving us such a framework of strong bones was, that it might support and give solidity to the soft and fleshy parts. Suppose, now, that there were no bones; and that the whole body was a mass of flesh only.

Would not the legs give way, and finally be crushed under the great weight of the body? Would not the arms be almost useless? Most certainly they would.

But there are several other important uses for bones, which might be mentioned. Some of them you will not very readily understand, till you know more about muscles and tendons. I will therefore omit them for the present.

Growth of Bone.—We are not born with the bones as hard as they become after we begin to walk and run about. At first, many of them are very soft; and a large number of them are in several pieces, with *cartilage* or gristle between them. After a few years, they grow firmly together. The bones of the head, in particular, are at first separate; and, without doing any injury to the soft brain within, will move a little. But after we become older, and the whole skull becomes firm, it would require a very considerable force to move them; and the consequences of moving them, were we able to do it, would be dangerous.

There is undoubtedly *life*, as it is often called, (though we hardly know what life is,)

in bones; but while we are well, there is not much feeling in them; and when the surgeon amputates or saws off a limb, the sawing of the bone does not usually cause much pain. In some cases of disease, the bones, it is true, are very tender, and then sawing them off is painful.

Vessels in Bones.—There are also many blood-vessels and nerves running about in small holes in the interior of bones; and wherever there are nerves, there is life. That blood is conveyed into and through the bones, can be made evident by forcing or injecting melted wax, colored like blood, into them.

Another method is employed to prove the same thing. If some small animal, as a rabbit, is fed a short time upon madder, most of the bones will be found tinged with the coloring principle of the madder.

We are now prepared, I think, to proceed with our studies on the frame-work of the house.

CHAPTER IV.

SILLS OF THE HOUSE.

Situation of the hip bones. Structure. The hip joint An abuse.

You well know, I suppose, that after the foundation walls of a common building—say a dwelling house—are well prepared, and made level, they lay on large sticks of timber, called sills. On these sills they place the *body* or principal portion of the building, and by means of joints, fasten it at the corners, as well as at other places.

Situation of the Hip Bones.—The sills of the house I live in are two large irregular bones, placed at the top of what I have, for the sake of convenience, called the pillars. These two large bones are very firm and strong. You will find so much difficulty in understanding my explanations of their shape without it, that I will show you a picture of them.

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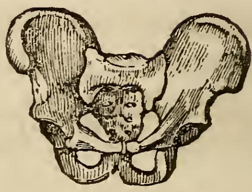


These bones are called in books the *ossa innominata*. *Os* is a Latin word for bone; and *ossa* is its plural, meaning more bones than one. *Innominata* means *without a name*, or nameless; but the very word *innominata* makes a tolerable name, though rather long. So if a very young child, found in the streets, whom nobody knew, should be called Peter Nameless, that word *nameless* would answer all purposes.

Structure.—I have said that the ossa innominata were very firm and strong. They are so in grown persons—but in a child they are less so, and are in three pieces, each of which has a different name. They are joined together by a firm gristle or cartilage. Behind, however, is a strong wedge-like bone, between them. Between this last bone, called the *sacrum*, and each of the ossa innominata, there is also a very strong gristle; but it is not so thick or strong as the one I have just men-

tioned. The ossa innominata and sacrum make a kind of cup, or deep bowl—open at the bottom, it is true, but still bowl-like in its shape. This bowl is called the *pelvis.*

Hip Joint.—The manner of fastening the thigh bone, or femur, to the hollow of the innominatum, is very remarkable. I shall give a particular account of it, with an engraving, farther along in the book; so that a few words must answer, for the present.

The hollow, where the femur is fastened, is shaped like the inside of an egg shell, with the small end broken off, and has received the name of *acetabulum*, from its supposed resemblance to the cup with which the ancients measured vinegar. The round end of the femur is fastened in this deep cavity by a very large and strong cord. The shoulder is often dislocated, or slipped out of its place; but this hollow is so deep, and the cord so strong, that nothing but very great violence will break the cord, or slip the femur out of its place.

An Abuse.—I have said that these two great bones are united by a very strong carti-

lage. This is true; but it is also true that while we are young, and even after we are older, if we have lived temperately, this cartilage, which is very thick, will stretch or yield much more than you would at first suppose possible. It is of very great importance to everybody—though much more so to some than to others—to preserve the soft and yielding nature of these cartilages as long as possible. To do this, you must run about and play much while young—not with violence, but like the lamb; you must labor moderately every day, as you grow older; you must rise with the lark, and go to bed almost as early as the fowls; you must breathe pure air; your drink must be water, and your food must be of the plainest and purest kinds, and not in excessive quantity—and must be well masticated or chewed. Then may you hope to preserve your bones and cartilages in a good and healthy state till you are quite old. But some of these things will be adverted to in other chapters.

CHAPTER V.

BODY OF THE HOUSE.

Height. The spine. Each vertebra. General description. The ribs. The breast bone. The collar bone. The shoulder blade.

Height.—Houses consist of one or more stories, according to the taste or design of the builder. Each story, as you know, forms a separate row or tier of rooms. The best houses are those with fewest stories. But most people prefer, if they are able, to have at least two stories—some three. In cities, where land is very costly, they sometimes have them four, five, seven, ten and eleven stories high. Four stories, in our large towns and cities, is very common. A house ten stories high, accommodating ten rows or tiers of people, one above another, is a curious sight. Houses of this description are to be met with in Edinburgh, and Paris, and some

other European cities. The house in which I live in has only two stories, besides a cupola.

THE SPINE.—-The principal post—the main pillar of the building—the spine, runs through both stories, and is of singular construction. We usually call it the *back-bone.* Here is a representation of it.

The spine is composed of no less than twenty-four separate pieces; each of which is

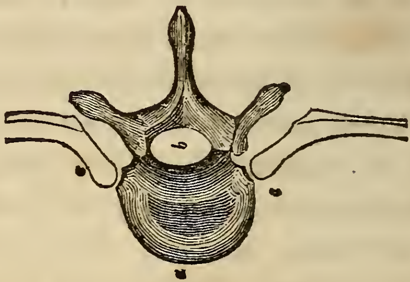
called a *vertebra*. The plural of vertebra is *vertebræ*.

The seven lower vertebræ are very large and strong. These parts of the frame are the principal supporters of the first or lower story. The twelve next above them, belonging to the second story, are somewhat smaller. The seven which connect the upper story to the cupola, are smaller still. Their size, in general, decreases—not suddenly, but gradually—from the bottom upwards. They are placed one above another, somewhat like tea-cups or saucers inverted and piled up.

The spine or back-bone is not only curious in its shape and structure, but of the utmost importance in the human frame. Had we no spine, the limbs, however well adapted they are for their purposes, could not act; but would fall powerless at each attempt to move them. It has been said, that "if one member," in any part of the body, "suffer, all the members suffer with it." This is especially true of the spine.

Each Vertebra.—Each vertebra has a hole of considerable size in the middle of it.

See *b* in the next engraving. What is there shown you, is the upper surface of one of the vertebræ, detached, as it were, from its neighbors, and standing by itself.



When the twenty-four vertebræ are placed one above another, in the position which they occupy in the living body, they contain a hollow channel through their whole length. This hollow is filled with a soft substance, very much resembling the marrow of other bones, but much more important. It seems like an arm or branch of the brain; for there is an open passage from the bottom of the cranium, or brain-pan, into the hollow of the spine.

There is a very curious contrivance for allowing the head to turn from side to side, without pressing upon the soft substance of

which I have just been speaking.* This is effected by having the top vertebra of all—called the atlas—move on a round and upward projection of the second vertebra, much like a tooth in shape, though larger, situated on the front part of the bone, and fastened in its proper situation by a cross band of gristly substance. By this means a side motion may be given to the head, without moving the rest of the bones of the spine at the same time.

General Description.—When the vertebræ are put together, in their proper position, there are large notches at the sides, between each two bones, so exactly matched together as to form a hole. Thus, there are as many holes in each side of the spine as there are vertebræ. Through these holes large branches of the marrow of the spine pass off, like the branches of a tree, to all parts of the body. These branches are called nerves. At first, they are pretty large; but they divide and subdivide, as they proceed towards the ex-

* Pressure upon the spinal marrow would be productive of very great mischief, and is therefore wisely provided against.

tremities of the frame, till they become very small. Their number, in all the soft parts of the body, particularly in the skin, is very great. I shall say more about these in another place.

Those two upward projections in the plate, which look much like arms, by interlocking with the bones above and below them, serve as braces to the whole spine. At the sides are drawn, in outline, parts of the ribs (*c e*.) These show where the spine and ribs come together. That projection, which in the engraving extends straight upwards, is called the spinous process of the vertebræ. It forms no part of the joint, but only serves as a point of insertion for the large muscles which move the back and head.

Between these bones, where the body of each (*a*) rests upon the other, is a tough substance or gristle, very yielding or elastic, almost like India rubber. This keeps the bones from wearing out too fast when they move, and yet it allows of their moving pretty freely.

The spine is, really, one of the most curious things in nature. Why, rope-dancers and tumblers will bend their heads back till they

almost touch their feet, and bring this straight pile of bones nearly into the shape of an ox-bow. Why does it not produce mischief in some way?

The gristle or cartilage between the vertebræ is very thick and strong, but at the same time very yielding, as I have already told you, like India rubber; and it is so constructed and placed, as will best allow the spine to bend about in all the various ways which even tumblers and rope-dancers could wish.

It is so elastic or springy, and also so readily compressed, that people who stand or walk much, are really a little shorter at night than they are in the morning. Rest gives the elastic cartilages time and opportunity to spring back again into their places, while we sleep, so that by the next morning we are as tall as ever.

I ought, however, to say—for it is a fact—that old people settle down a little, and are not so tall as in middle age; which is partly owing to these cartilages yielding and yielding till they become thinner.

If the soft marrow of the spine, (which runs down from the brain,) should happen to

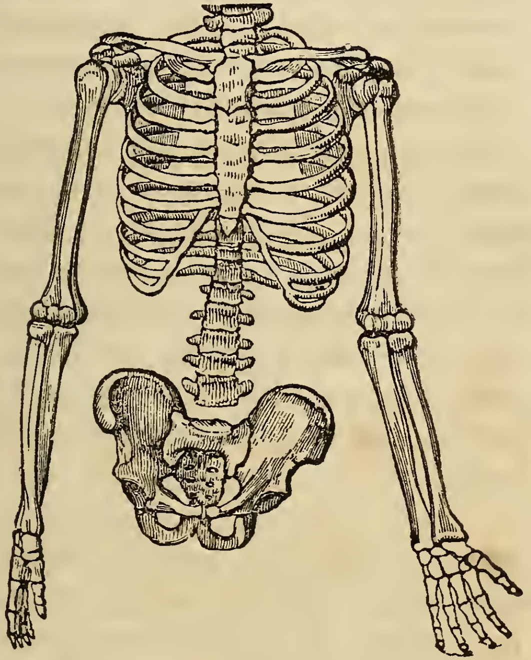
be bruised or injured, there would be an end of all motion, at least of the lower limbs. If the spine gets broken, it cannot be mended, and the sufferer will never wholly recover. How happy, then, that it is so contrived and so firmly put together, as rarely to be broken or dislocated!

The other and shorter posts of the house I live in, will be mentioned presently.

We are ready, now, to study the frame of the upper or second story of the building. It consists of a much greater number and variety of parts than the frame of the first story.

THE RIBS.—The ribs may be compared to the girders of a building; though they look more like the hoops of a cask than like girders. There are twelve of them on each side. Each of them is connected, by one of its ends, to the large post or spine; and, by the other, to a shorter post—the breast bone. Only seven, however, are joined closely to the breast bone itself. The other five go a part of the way across; the rest of the way they are formed of gristle or cartilage, and are united to each other and to the upper seven,

instead of being united directly to the breast bone. The former—the seven—are sometimes called the true ribs; the latter, the false ones. Here is a view of this part of the frame.



The length of the ribs increases from the first or upper one, till you come to the seventh, which is the longest. From the seventh to the twelfth, they grow shorter again, and the

cartilages, of course, become longer in the same proportion. The twelfth rib is very short.

The number of ribs is almost always twelve; but sometimes there are only eleven, and at others, thirteen. But instances of more or less than twelve do not probably occur in one person in a thousand.

In days of ignorance and superstition, a notion prevailed in some parts of the world—which is not yet wholly extinct—that *men* have one rib less on one side than on the other. It is said that as Eve was formed of a rib taken from Adam's side, he and all his male posterity have one rib the less for it. I hardly need to say that this notion is wholly unfounded.

Breast Bone.—I have just alluded to the breast bone. The name of this, in books, is the *sternum*. It has been usually considered as only *one* bone; but, like many others of the human frame, in infancy and youth it consists of several pieces, (three in number,) closely united by gristle or cartilage; but in advanced life, the whole usually becomes one solid bone

Long continued boiling, however, will separate almost any of the bones which are formed in this manner.

There are a few other parts of the frame of the second story which remain to be noticed, and which I will call the braces. They are four in number—two before and two behind.

The braces here alluded to are,

1. *The Collar Bone.*—This forms a kind of brace between the shoulder and the breast bone, and so nearly resembles a rib, that a separate cut, to show its shape and position, seems unnecessary. You will see it in two or three of the engravings, running across from the shoulder to the breast bone or sternum.

2. *The Shoulder Blade.*—This is a broad, flat bone, with ridges on it; and, at the fore part, is the hollow or socket, in which the round head or ball of the humerus or arm-bone lies and moves. This bone is called by anatomists the *scapula.*

While speaking of the shoulder blade, and saying that it consists merely of one large bone, I am reminded of an anecdote I saw lately, of an ignorant or quack bone-setter. He was attempting to set, that is, place in its

right position, a dislocated shoulder blade; and in order to make himself appear wondrous wise, as quacks are apt to do, he tried to encourage his patient to endure the severe pain he was causing him, "for," said he, "I have got three of the bones into their place already, and shall soon have the rest of them right!"

Here is a representation of this bone, about which the pretender or quack affected to know so much, and yet knew so little.

CHAPTER VI.

BODY OF THE HOUSE.—Continued.

The arms, or appendages. Account of the hand. Uses of the hand.

Arms.—These are not posts, for, in their natural position, they support nothing. They are not braces, for they strengthen no part of the frame. They are properly *appendages*, but they are very convenient ones; and though they can be torn off without spoiling the building, their loss very much injures it. They seem to answer, in some good degree, the purposes of stairs, ladders, tackles, pulleys, and other machinery for raising things from the ground, and conveying them to the upper part of a building. These appendages—we will at once call them arms and hands—however, answer a much better purpose than any of those.

The arm and hand, taken together, constitute a most wonderful apparatus for motion.

The particular structure of the joints, as well as the peculiarities of the hand, must be reserved for another place; but it is necessary to say a little about the arm.

The bones of the arm have a slight resemblance to those of the leg. The upper part consists of only one bone. This is long and round, and is called the *humerus*. It is fastened above to the scapula. Below, at the elbow, it is connected to the two bones of the lower half of the arm, by a joint like a hinge, and by ligaments or straps, which extend from near the lower end of the upper bone to the topmost end of the others. The largest of the two latter bones is called the *ulna*, which is a Latin word for cubit; because the arm, below the elbow, is usually considered about a cubit in length. The smaller one is called the *radius* or spoke, from its supposed resemblance to the spoke of a wheel. It is the bone from the elbow on a line with the thumb.

The connection at the shoulder is such, that the arm can be moved in almost every conceivable direction. The elbow joint only admits of one sort of motion, viz., forward and backward, like a door on its hinges. But the

connection of the radius, or smaller bone of the arm, with the ulna, or larger one, is such that it more than makes up for this deficiency. The upper end of the radius having a rotatory motion, in a depression of the ulna, allows the hand to be placed with each of its surfaces upwards with great facility. These motions are usually called *pronation,* when the palm of the hand is downwards, and *supination,* when the palm of the hand is upwards. Then the wrist, consisting, as it does, of eight bones, all movable, and being so connected with the lower bones of the arm as to admit of very free motion, renders the arm one of the most useful contrivances in the world. It will perform as varied and rapid movements as the trunk of the elephant; and were it not common, would probably excite equal surprise.

It was said that this whole portion of the building could be torn off without spoiling it. Cheselden, an English anatomist, relates that a miller had the whole arm, shoulder-blade and all, torn off, and yet his life was not injured. The great danger, in such cases, is from bleeding; but *torn* blood-vessels do not bleed so freely as those which are *cut.*

THE HAND.—I wish to give you a few particulars about the hand. This extremity of the arm is by far the most curious part of it. I do not know that there is a greater curiosity in the whole world than the human hand.

The truth is, many of the best, as well as the most curious objects in the world, are neglected in the same manner. Think of the thousand uses of *water*. What living thing could exist without it? And are we thankful for so valuable a gift?

The bones represented in the engraving are those of the left hand; and you look upon the top, or back side of it. The foot is also inserted here, but has been described in another place. See Chap. II.

The whole hand and wrist contain twenty-seven bones; nineteen in the former, and eight in the latter. The bones in the hand have a general resemblance, though some are much longer than others. The four longest, opposite figure 1, support the palm of the hand, and are joined at one end to the wrist bones, and at the other to the first joint of the fingers. The junction of these bones is effected, as are all the other joints of the body, by means of cartilaginous tips, which allow of free motion, and are strongly secured by ligaments. This series of bones is called the *metacarpus.*

The bones of the wrist are called the *carpus.* They are situated between the ulna (5) and radius (6) on the one side, and the metacarpal bones and the first bone of the thumb on the other. They are wedged together, like the stones of a pavement, only not quite so firmly, each bone being tipped with cartilage, and sustained by strong ligaments, which unite it

to its fellows. It is only necessary to add, that the bony structure of the wrist is of an arch-like form, with the convexity corresponding to the upper part of the hand; the convenience of which must be easily seen.

The first four bones of the fingers, opposite figure 2, are the longest. Those opposite 3 are shorter; the last, or those marked 4, are shorter still. The thumb has one bone less than the fingers. All the joints of the hand—and there are fourteen, besides the wrist—are hinge joints, and the ends of the bones are made a little like door hinges; of course they only bend in one direction. Where the fingers join to the metacarpal bones, there is much more freedom of motion than at the hinge-like finger joints; but the joint at the wrist admits of motion, very freely, in every direction.

When the bones of the hand are not quite as naked as they appear in the engraving, but are dressed up with muscles, tendons, membranes, nerves, arteries and veins, and covered with skin, nails, &c., in a manner which I cannot now fully describe, the whole presents a most beautiful appearance. Beautiful and useful as it is, however, and placed before our

eyes from the first time we see the light till we sleep in death, there are few things in the whole visible world, of which not only children, but adults, are so ignorant!

So important is the human hand, as a member of the system, that Sir Charles Bell's Bridgewater Treatise—a pretty large volume—is wholly devoted to the description of it. I will make, in this place, a short extract from that admirable work.

"The difference in the length of the fingers serves a thousand purposes, adapting the hand and fingers, as in holding a rod, a switch, a sword, a hammer, a pen or pencil, engraving tool, &c., in all which a secure hold and freedom of motion are admirably combined. Nothing is more remarkable than the manner in which the delicate and moving apparatus of the palm and fingers is guarded. The power with which the hand grasps, as when a sailor lays hold to raise his body to the rigging, would be too great for the texture of mere tendons, nerves and vessels; they would be crushed, were not every part that bears the pressure defended with a cushion of fat, as elastic as that which we have described in the

foot of the horse and the camel. To add to this, there is a muscle which runs across the palm of the hand, and supports the cushion on the inner edge. It is this muscle which, raising the inner edge of the palm, forms the drinking cup of Diogenes."

Uses of the Hand.—Small as this member of the frame is, it is a part of the utmost consequence. Even if the house the soul lives in were a palace, or had cost as much as St. Peter's Church at Rome, or the Pyramids of Egypt, it would be of very little use without it. And if all such houses in the world were without it, neither those houses, nor anything else, would long be worth much. The farmer could not sow his grain, nor plant his corn, nor weed or hoe it while growing, nor gather it when ripe. Nor, if it were raised, could the miller grind it, or the baker make it into bread. Neither could we raise anything else to eat in its stead. We might get along a few years with what is already raised; but what then? The fruits and roots and nuts which grow without cultivation—I mean without our labor—would not last us

and the thousands of beasts and birds which feed on them, very long.

Do you say that if we could get nothing else to eat, we should then have a good right to kill and eat animals? But we could not get them. How could we?

Besides all this, the tailor could not make us clothes, nor the hatter and milliner hats and bonnets, nor the shoemaker boots and shoes. When those already made were worn out, we should be obliged to go naked, summer and winter, in all climates; for we could not get even the skins of animals.

Then again, we could not write to other parts of the country for help, even if there were anybody to help us. Neither could the mariner seek a cargo of food in other countries; for he could not spread his sails, nor guide the helm of his vessel. In short, we could do nothing, long, to any purpose; but after gazing awhile upon each other's starving and emaciated frames, we should all lie together in one common tomb; and that tomb would be the surface of the earth, arched over with the blue canopy of the heavens; for nobody could be buried.

Some of you may think this representation of the sad case we should be in, rather exaggerated. "We should *not* be such helpless creatures," you may perhaps say. "Why, there is a story I have seen about a French woman, who was destitute of this instrument and some others, and yet she could do a great many sorts of work, and even *write, draw* and *sew*." Yes, and the story was undoubtedly true. I have heard stories like it before. I have heard of a man, in the same condition, who could write with his *breast*. His pen was fastened to a girdle, and then he could dip it in the ink, and write very well with it.

But these are extraordinary cases, in which nature is permitted, for some reason which we cannot discover, to depart from her established laws. Such occurrences, however, no more prove that people, constituted as we are, could live upon this earth without the aid of their hands, than the existence among his fellow creatures of a person afflicted with blindness, proves that all could get along well without the use of their eye-sight. The persons I have mentioned could not have made the pens and pencils to write and draw with, nor the needles

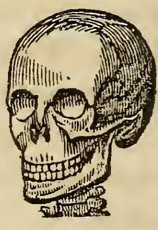
to sew with ; nor could the man have placed the pen in his girdle. And there are a thousand other necessary things which they could not do.

The human tongue is spoken of by an inspired writer as being a " little member," yet boasting great things. So this small member of the frame which we are talking of is a " little " affair, but great things depend upon it. It is a sort of connecting link, that, if used, serves to bind the human soul to the habitation it occupies, for a few years—seldom more than a hundred. Without it, or neglecting to use it, our lives, as *a race*, must soon terminate. " He that will not work, neither shall he eat," is a divine law ; and we could not work much without the aid of this beautiful piece of divine mechanism.

CHAPTER VII.

THE CUPOLA.

The cranium. Bones of the face and jaws. The teeth. Growth of the teeth. Structure of the teeth. Uses of the teeth. Bones of the ear. Bone of the throat.



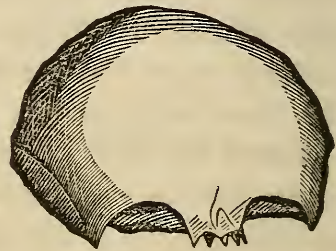
We come now to the cupola, by which I mean the skull, which is placed on the top of the great post. I have already told you that seven of the twenty-four pieces which form that post are situated above the second story of the building, and unite the skull to the trunk. You will observe the open chamber at the upper part, and you may also see the places for doors and windows.

I must stop here long enough to say that—unlike what is seen in ordinary dwellings—the doors and windows of the house I live in are in the cupola: there is not one door in either the first or second story. The windows, and some of the doors, are placed in front—the rest of the doors at the sides. The doors and windows themselves, as you know, properly belong to the covering; they will therefore be described under that head.

I have called the mouth and ears and nostrils doors, to keep up the metaphor which pervades the work; but the eyes may, with the greatest propriety, be regarded as windows. All sound, smell and taste come to us through these passages, and the machinery or organs near and within them: why then may they not properly be considered as doors?

The Cranium.—At the beginning of this chapter, I showed you a picture of the bones of the whole head. Now if the bones of the face and neck were taken quite away, and nothing left but the hollow brain-case, (*cranium*,) the appearance would be very different.

Here is a front view of a skull from which the bones below have thus been removed.



You see, in front, the top of the cavity or socket for each of the two eyes; and on one side, the place where the ear should be, in the living person. This brain-case is composed of eight bones, most of which are closely united by a rough edge, like that of a saw, the notches of which shut into each other as exactly as saw teeth would, and form what may be called seams. These seams are by anatomists called *sutures*, and are nine or ten in number.

One of the most important bones of the skull, or brain-pan, is that which stretches across the whole forehead, and is called the *os frontis*, or frontal bone. Another, across the

back side of the head, and shaped thus, Λ, is called the *os occipitis*. Its sharp top reaches to the crown of the head. Another piece, shaped a little like a clam-shell, lies around each ear. It is the *os temporis*. There are, of course, two of these. On the upper part of the head, surrounded by those already described, are the two *parietal* bones. Surrounded by them all, in the bottom of the skull, is a large bone, the *os sphenoides*, and a small one, the *os ethmoides*.

Now this whole space, as I shall hereafter show you more fully, is filled up with brain. In an adult, the brain weighs from two and a half to three and a quarter pounds. In a few instances, it has been found somewhat larger.

Bones of the Face and Jaws.—There are six bones on each side, to form the face. They are grouped together under the common name of the upper jaw. All of these bones, like those of the skull, have names assigned to them, and, like them, are united by what are called sutures.

The lower jaw is one strong bone, which has been imagined to resemble a horse-shoe,

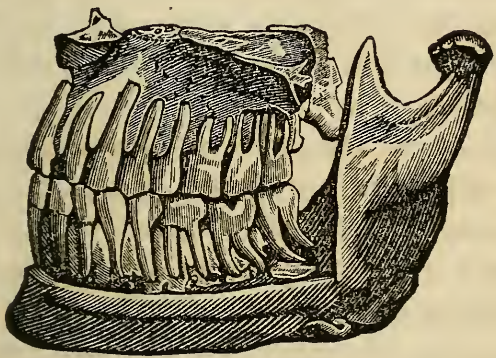
in its shape—but the resemblance is not very exact. Both the upper and lower jaws serve for the attachment of powerful muscles, which are more or less concerned in the work of mastication, or chewing.

THE TEETH.—Around one of the larger doors of the cupola is a most remarkable arrangement, which deserves a particular description. There is a slight resemblance, here, to one kind of wheel, with its component parts or cogs.

There are, however, no wheels here. There is, indeed, something like a mill, and it performs an operation not unlike grinding; but the motion by which this grinding is performed is much like that of a pestle and mortar One of the segments of a wheel, with its cogs, stands still during the operation, while the other moves up and down upon it, and breaks in pieces the substances which come between. It also slides a little to the right and left, upon the other, and thus renders the grinding process complete.

Look now at the engraving. This represents the left side of part of the bones of the

human face, as it would appear if the outside of both the upper and lower jaw were split off and taken away.



When the number of teeth is complete, in an adult, and none have been lost or drawn out, each jaw contains sixteen; and both, of course, thirty-two. In the engraving, you see eight of the teeth above and eight below; that is, just half of the whole. Children have but twenty teeth at first, or ten in each jaw. These twenty are sometimes called the milk teeth, because they appear while the child's principal food is milk. These they shed, between the ages of seven and fourteen years, and thirty-two new ones grow in their place.

There is a period in every child's life—say at about the age of six years—when, if it have not yet begun to shed its first set of teeth, there are *forty-eight* in both jaws—twenty in sight, and twenty-eight beneath them, lying deep in the jaws, at the roots of the former.

When you look at the jaw-bone of man, or any other animal, however, you do not see the roots or fangs of the teeth. They are encased or buried deep in the jaw. Those in front have only one root each; the grinders, or double teeth, have two, and sometimes more.

There are four kinds of teeth in each jaw, viz., four front teeth, two canine teeth, called also eye teeth, four small grinders, and six large grinders. Of these, half are of course on each side.

The fore teeth and eye teeth have but one root each. The small grinders do not often have more than one, but they are usually indented lengthwise, so as to have the appearance of two. The large grinders of the lower jaw have two roots, and those of the upper have three—two before, and one behind, or on the inside.

Who does not admire a good set of teeth? With some people, they are one of the principal marks of beauty. But they are *useful*, as well as handsome, as long as they remain sound. The teeth of some persons remain sound and beautiful all their days. Would you like to have yours do the same? Let us then attend to the following particular account of them; and perhaps when we know their nature and structure better, we may better know how to take care of them.

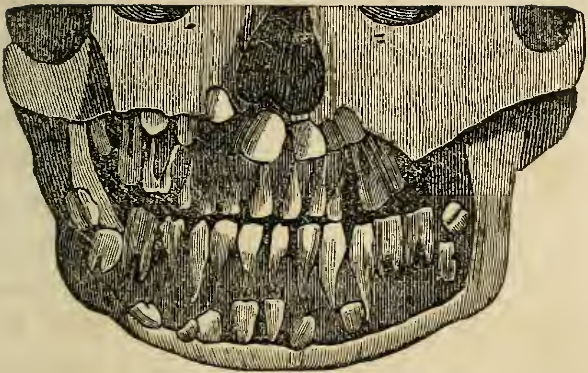
The teeth are not set into the jaw-bone itself, although they appear to be so; but into a bony appendage, which is called the *alveolar process*, which forms the true sockets of the teeth. These sockets, in old age, and when the teeth are no longer contained within them, become absorbed, and are carried away into the mass of circulating fluids, by a process yet to be mentioned. Hence arises that flatness of the lower jaw, and apparent shrinking of the face, which we observe in elderly persons.

Like the rest of the bones, the teeth consist principally of earthy substance—I mean lime. But at first, we can hardly be said to have

bones in us, of any kind. Some have begun to be a little solid, others have not. Where the bones afterwards are, we find a piece or lump of something which is nearly transparent, and more like jelly than bone. This in time ossifies, that is, becomes solid, and thus forms bone.

Growth of the Teeth.—The teeth, as well as the other bones, are at first mere pieces of jelly. They do not appear at birth, for they are in the jaw-bone. And what may seem strange to you, the lumps of jelly-like substance which make *both* sets of teeth, (those which are shed early, and also those which come afterwards in their place,) are there at the same time; the former near the edge of the jaw-bone, and the latter a little deeper within it.

It will greatly help you in understanding me, if you examine the following engraving. It shows the teeth as they appear in a child, before he has shed many of the first set. Near the roots of the regular teeth, you will see the beginning of some of the second growth.



When the soft pieces of jelly which form the teeth become bone, the process is as follows:—First, a hard speck commences in the centre of a tooth, which is deposited by the blood-vessels which nourish it; and this gradually grows larger, till all the jelly is absorbed and gone, and its place occupied by bone.

The teeth, however, consist of something else besides solid bone. If they did not, they would very soon wear out. Do you think a piece of common bone put in the place of a tooth, would last us to chew with half a century or more? By no means, you will say. I will therefore now tell you of the

Structure of the Teeth.—Each tooth consists of three parts—the *crown*, the *neck*, and the *fang*. The fang or root is the part which is set firmly in the jaw-bone, as if it were driven in like a nail. The neck is close to the edge of the jaw, where the skin or membrane which covers the jaw-bone joins tc the tooth and adheres to it. It is this membrane which the dentist separates from the tooth with his lancet, when he is about to extract it. The tooth is a little smaller here, like a neck, or as if a cord had been tied tightly around, and indented it. The crown or body of the tooth is that part which we see above the gum. Every tooth has blood, and feeling in it; but of this I cannot tell you the particulars now. You will find more about it in another chapter.

Now to prevent the teeth from wearing out, as a piece of common bone would, this crown is coated all over with something much harder than any bone in the human body. It is called *enamel*.

Uses of the Teeth.—Hard as it is, however, enamel will wear out in time. It

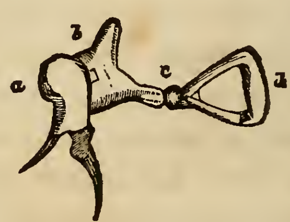
will wear out much sooner, if we pick the teeth, as many do, with pins and needles. These things are too hard, even for the hard enamel, and are apt to crumble it off. So is the wretched practice of cracking nuts with the teeth, or indeed the biting of any substance harder than the crust of good dry bread. If used to bite nothing harder than that, and if not injured in any other way—for there are a thousand ways of injuring the teeth—they may perhaps last all our lives. But if the enamel once gets broken away, so that air and other substances come to the softer bone under it, the tooth soon becomes hollow, or decays. Like any other part of this wonderful frame which God has given us, the teeth will, however, last the longer for being *moderately* used.

Those kinds of food and drink which injure the stomach, injure also the teeth, and cause the enamel to become soft, and break away. *Why* this is so, is a question which it would take too long to answer here; but you may believe the fact. In another place, I shal probably say more on this subject.

One thing more, however. The teeth must be kept perfectly clean. After eating

anything, always rinse them well. And if you rub them with a soft brush several times a day, it will do some good in the way of preserving them, and prove a means of saving you from the racking torments of the toothache.

BONES OF THE EAR.—Hardly any part of the wonderful machinery of the human body is more difficult to understand, than the structure and uses of the organ whose bony part I am about to describe. About three quarters of an inch or an inch within each of the two side doors of the cupola—the ears—is a film or membrane drawn tightly across the passage, like a drum head. This is called the membrane of the *tympanum*—tympanum being the Latin word for drum; and a cavity behind the membrane is called the tympanum.



In this latter cavity are four small bones, which are undoubtedly, in some way or other,

concerned with the sense of hearing. Sounds reach the brain through the passage of the ear; and if there were no ear, we should hear no sound. He who made the ear for sound doubtless made all parts of it, and there is reason to believe every part of it is useful.

The bone at *a* is called the *malleus*, because it has been supposed to resemble a mallet or hammer; but it looks as much like a crooked club, with a branch sticking out from it, as like either. It is close to the membrane of the tympanum, and touches it.

The *incus*, or anvil, (*b*,) is the next. I think it looks as much like one of the smaller double teeth as like an anvil.

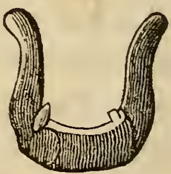
A little farther on is the little ring, (*c*.) It is very small, and seems to connect the incus with the stirrup. Anatomists, however, do not call it a ring. They call it by the hard name of *os orbiculare*. *Os* means bone, and *orbiculare* means ring-shaped.

The *stapes*, or stirrup, (*d*,) you cannot help knowing by its shape. It is the farthest within the head.

This little chain of bones is stretched along in the passage from the outside towards the

inside of the head, beginning at the tympanum, and ending at a small opening at a considerable distance within the head. They stand in the engraving nearly as they do in the right ear of a person, with the malleus outward, and the stapes inward toward the brain.

Bone of the Throat.—It is proper to mention, in this place, that there is a curious little bone inside of the neck, near the root of the tongue, called the *hyoides*, or *os hyoides*. This little member has been supposed to resemble the Greek letter *υ*, but it appears to resemble our own letter u nearly as much. You will examine it for yourselves.



This bone has something to do with keeping in their proper places the parts of the body which are concerned in speaking, chewing, swallowing, &c.

CHAPTER VIII.

THE HINGES.

The hip joint. Shoulder joint. Elbow joint. Ligaments. Capsules. Wear of the joints. Synovia. Abuses of the joints.

The house I live in differs in some respects, as you have already seen, from many other buildings. I will mention one more important point, in which there is a striking difference.

An ordinary building of wood, brick, or stone, is intended to stand firmly, and for some time. No part, excepting perhaps the doors and windows, is made for motion. The ends of the parts are usually fitted together by square edged joints, with the greatest exactness. Then to complete the whole, and make the frame as firm as possible, girders, studs, braces, &c. are added.

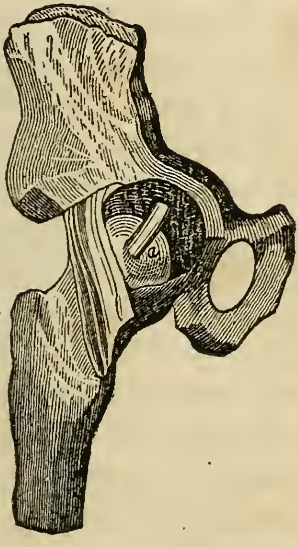
There are, indeed, a few parts of the house I occupy, which are not intended to move

much; but in general the reverse is the case. Even the girders, braces and studs are designed to regulate and direct motion, but not to prevent it wholly. And the joints, instead of being framed together by means of square tenons and deep mortices, and kept as dry as possible, are rounded and made smooth, and moistened by a sort of oil, to fit them for motion, rather than to hinder it.

There are indeed a few joints—if joints they ought to be called—which are firm and un yielding. I refer to the teeth. These, as we have seen, are set into the jaw-bones, as firmly as tenons are into mortices, and more so. They seem to stand more like nails or spikes, when they are driven into planks or timbers. The bones of the head, too, are joined firmly together in adults, as you have already been told.

Some of the joints of the human frame are real hinges. To this class belong the knee joints, the joints of the toes and fingers, and those of the elbow. The lower jaw may also be called a hinge joint. The ankle joints, the joints of the wrists, and indeed many others, sometimes move like hinges, but they perform other and very different motions besides.

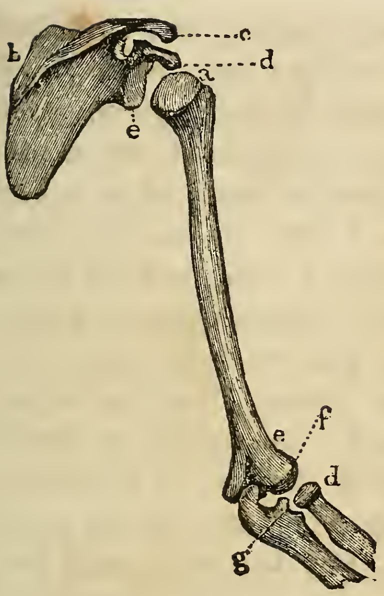
Hip Joint.—But the most curious joints in the human frame are what are called the ball and socket joints. The more important of these are, the shoulder and the hip. I will show you a plate of the one at the hip.



At *a* you see the deep hollow or socket in the bone, where the round head of the femur or thigh bone moves. This round head is drawn back from the bottom of the socket a little way, in order to show the round ligament

near *a*. The latter is a very tough, strong cord, fixed by one end at the bottom of the socket, very firmly; and by the other, fastened to the round head of the femur. If it were not for this ligament, this joint would be dislocated, or slipped out of its place, a thousand times more frequently than at present, for it now but seldom happens. I ought also to say, that there is a tough, gristly rim around the socket at the hip, which greatly increases its depth. This socket is called the *acetabulum*, or vinegar cup. It was supposed, as I observed before, to resemble one kind of vinegar cup in use among the Romans.

I am now going to show you a figure of another ball and socket joint, and also of a hinge joint—the shoulder and the elbow. Every one understands the nature of a hinge, or at least may easily understand it. It is said that the first mechanic who made a door hinge took the idea of it from the hinge joint of some dead animal; but we do not know that this notion is correct. But now for the engraving.



I will first describe the joint of the elbow The lower portion of the arm is made up of two bones; one larger, called the *ulna*, and another smaller, called the *radius*. The upper end of the smaller bone, *d*, is a little rounded, and lies against a small hollow in the other bone, the ulna, at *g*, to which it is tied by cords, called ligaments, particularly by one which goes round it like a band. The ends of these two bones, thus united, turn on the end of the upper one, which is rounded and

tipped with cartilage, and thus fitted for the purpose, as you may see at *f*. They are kept together in a living person, (as indeed all bones are,) by broad and short straps or cords, called ligaments, which adhere to each end of the bone a little way from the joint, and are very tight and strong, and yet not so tight as to hinder the proper degree of motion.

But a ball and socket joint is, if possible, still more curious. The bone which is represented at *b*, is the *scapula*, or shoulder-blade. The hollow place at *e*, is the socket in which the round end or ball *a*, of the upper bone of the arm, (the humerus,) plays freely, when the arm is moved. The socket is so shallow, and the ligaments so long, in order to enable us to make almost every kind of motion with our arms, that it is much more easily slipped out of joint or dislocated, than the hinge joints are. Even the hip, which is also a ball and socket joint, has a much deeper socket; and it is partly on this account, and partly by a different arrangement of the muscles, that we cannot swing our legs round with quite as much freedom as we can our arms.

But though the shoulder joint is pretty easily dislocated, it is not so easy to put it in its place again, when it once gets out, as you may imagine. It sometimes requires all the skill of a wise surgeon, and all the strength of one or two strong men.

The number of hinge joints and other joints in the frame of the house I live in is very great. It must be nearly if not quite a hundred and fifty. I do not think there are many frames that have more hinges in them than the human.

You see the wisdom of the great Creator fully displayed in this structure and connection of the bones. What if the joint of the knee would move in every direction, like that of the shoulder? Do you not see that when we walked, the legs would have dangled about strangely, instead of moving backwards and forwards in one direction only? And is it not plain that we could never have stood firmly on the ground? In like manner, how very inconvenient it would have been to have our finger joints move one way as well as another! How confined and cramped, moreover, would have been the motions of the arm, if the

shoulder had been like the knee, and had only permitted the arm to swing backwards and forwards, without our being able to carry it outward from the body!

The builders of machines have sometimes made joints in their machinery very much like the shoulder joint; but it is doubtful whether they could ever have contrived them, if they had not first looked at the bones of man, or some other animal; for other animals have these various sorts of joints, as well as man.

Ligaments.—But how are the joints held in their places? For when we take up a bone which has lain, perhaps for years, bleaching in the sun and rain, we only see the ends smooth, and some of them hinge-like; and if we take up two such bones, and put them together, they will not stay in that condition a moment, unless they are fastened by strings or wires, or something of the kind. How, then, are they kept together in the living person? This is what I am now about to tell you.

They are held together by short and strong straps, called ligaments. Some of them, however, are quite long, and begin at a considera-

ble distance, say an inch or two, from the very end of one bone, and then, after passing over the joint, are fastened into the next. The strap or ligament does not adhere or stick to the joint, as it passes loosely over it, but is only fastened strongly, where it rises, and where it is inserted, as if it were there glued to the bone. The inside, where, in crossing, it lies against or rests gently on the joint, is very smooth ; and is kept moist as well as smooth ; so that the joint, in moving, may not grate nor wear out.

These ligaments are white and shining, but not always very thick. They are very strong Some of them are as narrow as a piece of tape. Others, as at the sides of the knee or the shoulder, are very wide. Some cross each other, as at the knee. The latter are shown in the engraving. There are others still, that go all round the joint, and completely shut it up. It is as if the ends of the joints were put into the two open ends of a short cylinder, or rather of a short bag or purse, and the open ends were then gathered round, and fastened tightly to the two bones. Do you not see that, in this way, the joint would be completely shut up, as in a sack?

Capsules.—These bags or sacks are called *capsules*, and their coverings, that is, the materials of which they are formed, *capsular ligaments*. They are very numerous in the human body. Their use is to keep the joint from being easily slipped out or dislocated. They are also intended for another purpose, scarcely less important—a purpose which shows, in a striking manner, the wisdom of the Creator in contriving the human frame.

The wagoner or stage driver has a mixture of tar, or perhaps tar and oil, some of which he often puts upon the axle of his carriage, where the wheel turns upon it. If this were not done, the axletree would soon become very dry, and the wheel would wear it. If the carriage were driven very fast, it might happen that it would take fire; for rubbing dry wood together, as you know, will produce fire. More than one stage coach has been set on fire, in this way, within a few years.

Wear of the Joints.—Now what prevents the joints of the human body from wearing out rapidly, in the same manner, when we walk much, or run swiftly?

The Father of the universe is the preserver as well as the creator of this "wondrous frame." Were there not something done to keep these joints oiled, if I may so call it, they would not last long. Take the knee, for example, and think what a vast deal of friction or rubbing together of the end of the thigh-bone and of the two leg bones, there must be!

A traveller probably swings each leg, in walking, about 1200 times in a mile. If he

should travel 40 miles a day—and many travel more than this—it would be 48,000 times a day. If he should continue to walk only 40 miles a day, all the year except Sundays, he would, at the same rate, swing each knee 15,024,000 times.

If he should perform the latter feat every year, from the time he was 20 years old till he was 70, or a period of half a century, the number of movements would be 751,200,000!

"A continual dropping," it is said, and it means dropping of water, "will wear away a rock;" and the saying, though old, is true. And this continued rubbing of the bones of the knee together, if they were allowed to get dry, would wear them so much in a single day, that we should hear a grating noise at every step, long before night. And, in a very few days, the bones would be completely worn out, and unfit for use. I question if they would last even a whole day. Iron or steel, or even the hardest thing you can think of in the world, would wear out in a very short time. What, then, can be the reason why the knees and other joints do not wear out? There is no place to put in tar or oil to prevent it.

Synovia.—I have said that many of the joints are completely shut up, as if by a sack. Now the Author of the frame has so contrived it, that a substance called *synovia*, which answers all the purposes of oil or tar, continually oozes out on the inside of the ligaments at the joints, and keeps the ligaments themselves, and the joints, soft and moist. Can anything be more curious? Can anything prove, more clearly, a great Designer, or, as I might say, a great Master Builder.

One thing may be advantageously remembered. The synovia or liquor which thus oozes out to lubricate the joints, will be of just the right quality and quantity if we are in the most perfect health. If we are unwell, there may be too little or too much, or it may be too thick or too thin. When we use food or drink that is too heating or irritating, it seems to dry the blood; and, after a while, the synovia will become less in quantity, or of poorer quality. Persons who use much spirits or opium, or eat improper or heating food, are very apt, in the end, to have a grating in their knees and other joints, when they move.

Such persons often go to the "doctor" to inquire what the matter is; but they might as well take care of themselves. Prevention—where we can prevent any evil—is always better than cure. Those who live on a moderate quantity of plain food, and drink pure water, and work at something steadily, but moderately, rarely have any trouble of this sort.

It has been said that the ligaments hold the joints together. They do; but the tendons or straps, which go off from the ends of the muscles, and are fastened into the bones around their joints, help greatly to hold them together. There are some very ingenious contrivances to keep the joints firm and yet movable, which I cannot describe now.

Abuses of the Joints.—That the great Creator made the joints to be used, is proved from their curious structure, and from the substance prepared to moisten them; but that they were not made to be used too violently is also proved by the fact that if thus used, they become diseased. Sometimes the liquor called synovia dries away; in these cases, we hear the grating sound already mentioned; at oth-

ers, the joints become painful, or perhaps swell. It is but seldom, however, that they become diseased from mere walking, if we walk ever so much, unless we are intemperate or otherwise irregular in our habits.

One of the worst abuses of the joints is by wrestling. I have seen a great many famous wrestlers, who, when they became old, had stiff, or lame, or swelled knees or hips. They were tortured almost to death with these complaints. Sometimes the physician calls the complaint gout, sometimes rheumatism.

No doubt people have both the gout and the rheumatism from other causes besides wrestling, such as catching cold, excess in eating and drinking, the use of spirits, tobacco, &c., &c. But it often happens that wrestling, when it does not produce all the mischief, unites with other causes to produce it; and it sometimes does the whole. In fact, no person can use his joints with very great violence, either in wrestling or in hard labor, without suffering from it, especially when he becomes old, if he lives to see old age; which, in such cases, is not very common.

CHAPTER IX.

REVIEW.

Number of bones. Skeletons. Anatomy. Physiology
Uses of bones.

Number of Bones.—Let us here sum up or review what we have learned. This is always important in the pursuit of any study. Some teachers review every week, and some oftener still. Your parents or teachers, while you are studying this work, will, I hope, require you to review at the end of every chapter.

The cranium, or part of the head which holds the brain, consists of eight different bones. There are fourteen bones of the face, besides thirty-two teeth. Then there are four very small bones in each ear, and one at the root of the tongue. Thus the whole head, above the neck, contains sixty-three bones. The neck has seven ; but as these form the

upper part of the spine, they are usually reckoned with those of the body.

The spine, or back-bone, contains twenty-four pieces, called vertebræ; and between these and the lower extremities are four bones more. There are twenty-four ribs, that is, twelve on each side, and a breast bone, or sternum, down the middle of the front. Thus the whole of what we commonly call the body, contains fifty-three bones.

The whole upper extremity, including the hand, arm, clavicle, or collar bone, and scapula, or shoulder blade, consists of thirty-two pieces, or sixty-four on both sides. Each lower extremity includes thirty bones; and thus both together make sixty, besides the small sesamoid bones.

Now if we add together these several sums, we shall find the amount two hundred and forty. A complete human skeleton, then, would contain no less than two hundred and forty bones! Who would suppose so, from the mere view of an individual, while in the act of standing! But when we come to see him walking, or in motion otherwise, we begin to find he has a great many joints in him, and

of course a great many bones. At every part of the body where the bones meet, there is more or less of motion, (excepting at the junction of the several portions forming the head, face, teeth and hips,) and these may all be moved in nearly the same instant. Thus there are, in the human frame, about one hundred and eighty joints.

We may indeed add to this number the small sesamoid bones, found in the thumbs and great toes of older persons, and somewhat resembling the knee-pan in shape, but very diminutive in size. Of these there are often two in each large joint of the great toe, and as many in the large joint of each thumb. Adding these, then, to the two hundred and forty, we should have for the whole number of bones in the human frame, two hundred and forty-eight.

Some make the number about two hundred and sixty; but in order to this, they reckon fourteen sesamoid bones. It should be remembered that the number of the sesamoid bones varies greatly in different persons, although nearly all adults have some of them. They are hardly ever larger than half a pea.

Some individuals have them in other parts of the body, besides those already mentioned.

We may remember also that some persons have two small fragments of bone in the skull, separate from the rest, called *ossa wormiana.* They are irregular in shape, and seldom larger than a good sized bean.

It should also be observed, that there is a small fragment of something which is bony in its appearance, usually found in the very middle of the soft part of the brain. What the use of it is, nobody knows, except the Creator.

Besides all this, the breast bone, the ossa innominata, and many other bones of the body, are in several pieces, while we are young; and some of them are not very strongly united, even when we are old.

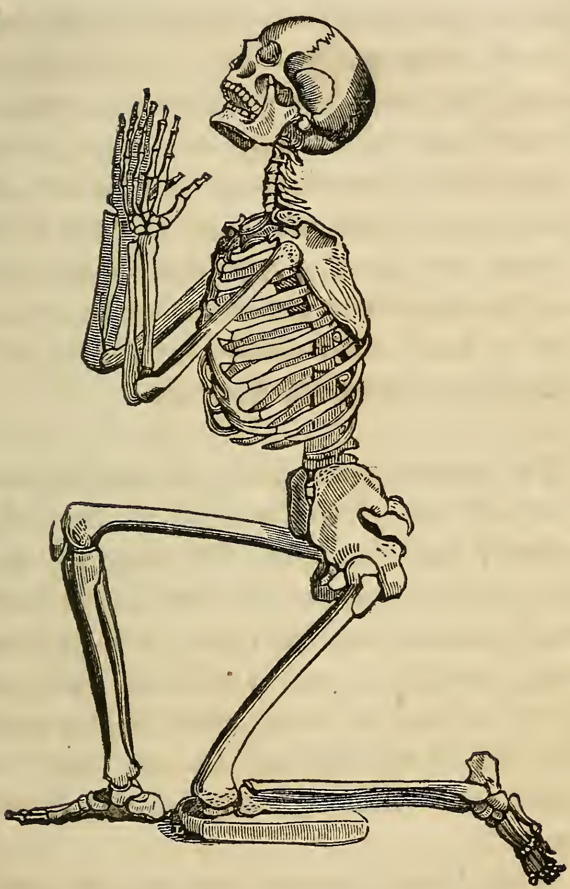
Some few individuals may be found, who have a still greater number of bones; but these are properly diseased persons. A bony or chalky substance is often found in the flesh of those who have the gout. Some of the gristly parts of the body—I mean the cartilages and ligaments—occasionally change into bone; and so do small portions of the great

arteries, or tubes which carry the blood. In some diseases, too, the bones become soft and bend, or separate into several pieces. Here and there we find a person with six fingers on each hand, or six toes on each foot, and sometimes with both; but these supernumerary fingers and toes do not always have bones in them.

Skeletons.—When the bones of a human being or any other animal are put together, and fastened to each other by pieces of wire, the whole is called a *skeleton.*

There is another kind of skeleton, but it is not so common. It is made by stripping off all the soft parts of the body, excepting the ligaments; these are suffered to remain. The whole is then very thoroughly dried. This saves the trouble of having wires.

The engraving on the next page represents the human skeleton fastened together by wires, in the usual manner. It is represented in this posture, in order to give you a different view from that opposite the title-page.



ANATOMY.—The study of the nature and structure of the bones, and nothing but the bones, is called *osteology*; that of the muscles, and nothing else, *myology*, &c. But as most

people who study these go farther, and learn also the shape and structure of the heart, the lungs, the brain, the blood-vessels, and, in fact, all parts of the body, some more general name would seem necessary for what they do. So we say of those who study all parts of the human body just as it appears the moment the soul leaves it—bones, muscles, tendons, brain, nerves, heart, blood-vessels, lungs, skin, &c., that they are studying Anatomy.

Physiology.—Physiology is something more than all this. It is the study of the living animal; how the heart, the brain, the eye, the ear, the muscles, the bones, and every other part act—and their uses; and an interesting study it is, too. David, the king, probably believed so when, after thinking about the curious structure of his own body, he exclaimed—"I am fearfully and wonderfully made."

King David, however, had probably never seen a complete human skeleton; for in those days, it was generally thought very wrong to use the dead body of a human being for any such purpose. Sometimes, however, they

used *parts* of domestic animals—dogs, oxen, &c.—which were of some little service. But of late years, many people think it quite right to examine and dissect (separate) human bodies after death, if by so doing they can learn how to cure or prevent the diseases of the living; not very often, to be sure; and only the bodies of criminals, such as have no friends, relatives, &c.

In making this little book, it is my object to teach you something of both Anatomy and Physiology. What I have taught you thus far has been chiefly Anatomy.

The remaining chapters will embrace much more of Physiology. It is a subject which it will be a little more difficult for you to understand than Anatomy; but it will also be much more pleasant, when once understood. There are many wonderful things to be told about the human body.

Uses of Bones.—Before I close this chapter, you must just allow me to say, that bones are often used in the arts. Ivory is nothing but bone—the teeth of the elephant. The bones of man, so far as I know, have not

been often used in the arts. They have usually been either burned up, as in some of the eastern countries, or left to decay in the grave, as in our own.

The shells of many of the *testaceous* and *crustaceous* animals are of very great value. Such are the tortoise shell, the pearl, &c. Of tortoise shell combs, and pearl buttons, you must all, I suppose, have heard; and most of you have seen them.

The handles of many kinds of knives and forks, as well as a great number of little articles which are used every day, are made of bone. Ivory is the tooth of the elephant; and whalebone is from the jaws of that enormous sea animal, the whale. From the horns of animals are made combs, lanterns, whip handles, &c.

The bones and shells of animals serve not only as a support to their softer parts, but also as a defence. What would become of the tender frame of the poor tortoise, lobster, crab and oyster, if they were not covered over, as with a shield, by a hard buckler of shell? The soft parts of the human body, especially what we call the vital organs, are, in many

instances, well defended by the solid frame on the outside of them, in the same manner. Such are the brain, the spinal marrow, the lungs, the heart and the liver.

Now one principal part of all the shells of animals is lime; so that there is not so much difference between the bones of man and the shell of the tortoise or the lobster, as you may have supposed, though the color is somewhat different. A very large proportion of the lobster shell is lime; in the tortoise shell, the proportion is small. Horn has but a very little lime in it. Bones, as I have already observed, contain a very large proportion of this substance.

There is one use made of the bones of the human frame, which it is rather shocking to think of. It is well known that the bones of other animals make a very excellent manure, for enriching the soil. The Germans have long used bones as a manure, in their hot houses. It is not, however, very generally known, I believe, that the bones of men are used for this purpose.

Some of you have read, I suppose, about the great battles which were fought in Ger-

many and France many years ago, in the days of Bonaparte, when thousands of men were often left dead on the field, and their bones afterwards almost covered the ground.

Within a few years, these human bones, it is stated, have been brought to England, and ground by means of steam-engines and other powerful machinery, and used as manure. It is computed that in 1832, a million of bushels of bones of men and horses were brought from the continent over to England, and used by the farmers of Yorkshire, Nottinghamshire, and the neighboring counties.

In this country, the consequences of war have not yet been dreadful enough to render bones very abundant or cheap. The bodies of men slain in war, as well as of those who have died in peace, have in general been decently buried. May we not hope that our country will never be deluged with blood and covered with bones, as some of the countries of Europe and Asia have been? May we not hope that at our death, our bodies will be buried quietly in the usual manner—"ashes" returning "to ashes,"—"dust to dust,"—and the soul to the "God who gave it?"

CHAPTER X.

COVERING OF THE HOUSE.

The periosteum. The muscles. The tendons. Structure of the muscles. Action of muscles. Illustrations. About fat. Reflections.

The covering of the house I live in differs more from that of other buildings—that is, possesses more peculiarities—than any other part of it; though every part of it is admirable. It differs from ordinary buildings in containing no sharp corners or square edges; for everything, even the smallest part, is more or less rounded. It is as if the divine Architect had regarded roundness as a beauty, and squareness a deformity, in the animal and vegetable world; while, on the contrary, square sides, square edges and sharp corners appear, in human architecture, to be peculiarly beautiful. Not only are single buildings erected with regard to squareness of form, but whole towns and cities.

The Periosteum.—How different is the structure of the house I live in! Every bone in the frame, as if to prevent the possibility of having any rough sides or corners, is neatly covered with a very thin membranous substance, which is called the *periosteum*. *Peri* means around, and *osteum* means the bone or bones.

There is a plain reason for this periosteum being provided. The frames of our common buildings are made to stand firmly; they are not intended for motion; while the frame, and almost every part of the human body, is made to move. But where there is motion, it is desirable that the parts should be rounded as much as possible; and every possible pains taken to prevent friction or wearing.

After every bone* is covered over with this thin substance—the periosteum—we have next the muscles and tendons. It is the muscles

* Or rather, every bone except the teeth. The teeth, where they stand out of the gums, are covered with enamel. A thin membrane like the periosteum, would do no good, as it would soon wear out in eating. The ends of the bones also, where they rub against each other—I mean at the joints—are covered with a white, elastic substance, which is not exactly like the periosteum.

generally, which give roundness and beauty to the human body and limbs. A large number of them are situated on the bones, especially the long bones; but a few are extended between them. The bones are generally smallest in the middle, and increase in size towards the extremities, at the joints; but the muscles are usually the reverse of this. They are largest towards the middle of the bones, and grow smaller towards their extremities.

We have a striking example of what I have just stated, in the case of the arms. The bones of the arm, as seen in the skeleton, are so large at the joints, and so small in the middle, as to make the limb appear almost ugly. But when we come to see it dressed up with muscles, and covered with the skin, it is very well proportioned. The elbow, in most persons, is scarcely larger than the arm is, both above and below it; and this is caused, as I have said before, by the muscles. They are larger where the bones are smaller, and grow smaller till they come near the joints, where they run into tendons.

But before I go farther, I must tell you what muscles and tendons are.

THE MUSCLES.—The muscles are the lean part of the flesh. They are, as you have probably observed, of a reddish color. The red color is caused by the blood in them; for it is not only true that blood, in small veins and arteries, runs through them in every direction, but it also tinges their whole substance. We know this is so, because when the muscles have been soaked and boiled for some time, their redness disappears. Even when boiled for the table, the muscular parts of animals are of a paler red than when they were first separated from the mass of flesh to which they belonged.

THE TENDONS.—Some of the muscles are fastened at once to the bones, and grow, as it were, into them. In this case, the covering of the bones, or periosteum, seems like a kind of glue, intended to cement the muscle and bone together. But, in general, the muscles are not themselves fastened to the bone, but terminate towards each end by one or more tendons. These tendons are white, flattened substances, like belts or straps, and are very tough and unyielding. When boiled with the

muscle to which they are attached, they are sometimes called whit-leather; and it is almost as difficult to break them to pieces with our teeth, as if they were of real leather. The muscles, then, usually terminate in tendons, and it is the latter which grow to the bone; though the muscles sometimes adhere to the bone directly at one end, without the help of tendons.

STRUCTURE OF MUSCLES.—The substance of the muscle is thready or fibrous. You have probably observed that a piece of lean meat, when boiled, has this thready, fibrous appearance; but there is one thing about the muscles, which does not so readily appear after boiling as it does before. A piece of meat, to be boiled, is usually cut off in such a manner that it takes parts of several different muscles; and the whole, in this way, seems like a solid or nearly solid mass; whereas it could be parted out, with a very little care, each muscle by itself—though not so easily after cooking. Such is the case with a piece of flesh taken from the leg of the ox; and such would be the case with a piece taken

from the human leg or arm. These separate muscles are connected to each other by means of what is called the cellular substance—a fine, woolly sort of membrane, which I shall have occasion to describe hereafter. Each thread or fibre of each muscle is also connected with each other fibre which lies next to it, by the same sort of cellular or woolly membrane.

Thus, as you see, a mass of lean flesh, such as we boil, and such as we see on cutting into the limbs or other parts of an animal, consists of smaller bundles of flesh, connected together by the cellular membrane, but not so tightly as to hinder each bundle or muscle from moving or sliding about a little among the rest. Now each muscle, in like manner, consists of a great multitude of fibres, also connected together by cellular membrane. It is also thought, by many anatomists, that each fibre is made up of a great many smaller fibres, so small as not to be seen by the naked eye.

The number of muscles in the human body is very great. Anatomists do not agree about the number, because there are many which some reckon as only one muscle, while others call them two, (for they really have a double

appearance;) and because a few are so small that some do not count them at all. They are usually, though not always, arranged in pairs; that is, there is one on the right side of the body exactly like one on the left side, opposite to it; and so on. We cannot reckon the whole number at less than four hundred and fifty, and some make it five hundred and twenty, or even more.

I have said that these muscles—many of them—end in tendons, or thin whitish straps. Sometimes they terminate in two tendons. The *biceps muscle*, (so called from *bi*, two, and *caput*, a head,) lies on the front part of the arm, having its upper end fastened to the top of the scapula, or shoulder blade, by two tendons, while the lower end is attached to the upper part of that bone of the fore arm which is called the radius, by one tendon only.

The next engraving will give you a pretty correct idea of the shape of the muscle I have just been speaking of, as well as of muscles and tendons in general. You must remember, however, that only a few muscles have double tendons, as this has; and that they are far from being all of them so perfect and beauti

ful as this. Some are quite ill shaped, and irregular in their appearance.

You will perceive in the figure, at a short distance from the bottom, a sort of square projection, by which the artist meant to represent a small portion of a tendinous expansion,

or sheath, which goes off at this part of the muscle, and dipping or turning down among, and uniting with the flesh of the fore arm, assists in binding the whole together, and preserving a unity of action.

Action of Muscles.—In front of St. Peter's Church, at Rome, stands an obelisk of red Egyptian granite, 124 feet high. It was brought from Egypt to Rome, by order of the Roman Emperor Caligula, where it lay partly buried in the earth, on the spot where it was laid down, till about 250 years ago, when Pope Sixtus V, by the help of forty-one strong pieces of machinery, eight hundred men, and one hundred and sixty horses, in eight days succeeded in getting it out of the ground; but it took four months more to remove it fifty or sixty rods farther, to its present situation.

When they had at length reached the spot, the grand difficulty was to raise it. They erected a pedestal or foot piece, shaped like four lions, for it to rest on; and by means of powerful machines and many strong ropes and tackles, they placed the bottom of it on the

pedestal. Then they began, with their machinery, to raise it. But when it was nearly up, so that it would almost stand, the ropes, it is said, had stretched so much more than the master workman expected, that it would go no further.

What was to be done? Fontana, the master workman, had forbid all talking, and they now stood holding upon the tackles so silently that you might have heard a whisper. Suddenly an English sailor cried out—"Wet the ropes." This was no sooner said than done; when, to the surprise and joy of everybody, the ropes shrunk just enough to raise the obelisk to its place, where it has now stood nearly 250 years; and where it may perhaps continue to stand many thousand years, unless an earthquake should shake it down.

You will probably begin to wonder what this story has to do with anatomy and physiology. I will tell you. The muscles are the parts by means of which we move our heads, our arms, our legs, &c. In fact, we could not so much as move a finger, or any part of our bodies, without them.

But they move these parts by contracting, or shrinking. Being fastened to the bones at each end, they must, if they shrink, draw one of the bones to which they are strongly fastened towards the other. If the muscles between the shoulder and elbow shrink, as they will whenever we wish to move the arm, they must either draw the shoulder towards the elbow, or the arm below the elbow towards the shoulder. You can judge for yourselves which would be most likely to happen.

The muscles will not contract or shrink a great deal, it is true; but they will do so much more, in proportion to their length, than wetted ropes can.

Illustrations.—I must explain this matter by another engraving. Here is a picture of the right arm. It is represented as if everything had been cut away from the bone, except the single muscle of which I was just now speaking, (the biceps,) and the skin. It is represented, too, as already shrunk, and the arm drawn up as far as possible towards the shoulder. You see how large this muscle is in the middle, when thus contracted, and also

the point at which it is inserted, below the elbow.

In one respect, a muscle does not shrink *like* a rope; for the latter, when it shortens, or grows larger, swells all the way alike; but when a muscle contracts to draw up a limb, it swells chiefly in the middle. Some muscles do not swell so much as this one does, when they shorten; but they are all enlarged more or less, when they move, at our will, any part of our body.

Perhaps you do not yet understand how a muscle, by contracting or shortening, pulls up the arm. I will endeavor to make it more plain.

I now sit at my table—my right arm lying upon it. For the sake of explanation, I will consider it as helpless as a stick. Now if I wish to get my hand to my head, how is it to be done? If a piece of dry rope, fastened by one end at the shoulder, and by the other to my hand, were moistened, it would shrink, and raise my hand a little way from the table, but not very far.

But suppose the lower end of the rope were fastened round the middle of my arm, and then made to shrink; would it not raise the hand higher than before—I mean, if the elbow remained where it was? It certainly would. Still it would not bring the hand up to the head, nor half way to it. But suppose, once more, that the lower end of the rope were fastened still nearer the elbow. The nearer it is, the farther it draws up the hand, when it shrinks.

Now the end, or *tendon* of the muscle which shrinks, to draw the hand up towards the head, is fastened to the arm below the elbow; and so close to it that, in shrinking only an inch or so, it draws the hand up to the head. If you lay the other hand on your

arm, between the shoulder and the elbow, you can feel the muscle contract, and at the same time see it swell out.

If the tendon of the lower end of this muscle were fastened lower down, that is, farther from the elbow, it would start out so far, when we raise our arm, as to make a very singular and awkward appearance, unless a band were put round it at the elbow, which would be very inconvenient. As it now is, the tendon starts out a little way, as you may see by the engraving, and as you may know by placing your hand on it, or under the knee, while you are bending the limb. As the matter is contrived by the great Architect, it renders the arm very useful, gives it a good shape, and ought to raise our thoughts in gratitude to infinite Wisdom.

One illustration more. Suppose I am sitting at church, with my pew door open, and wish to close it without disturbing anybody. Shall I take hold of it near the hinge, so that a little moving of my hand and arm will answer the purpose, or shall I take hold farther off? Again, suppose a rope were to do the work—would not one which should be tied

to the door close to the hinge, and then made to shrink, say an inch, draw it together much more than if it were tied at the distance of a foot from the hinge? It is true that in shutting a door by taking hold close to the hinge, we must pull *harder* than if we took hold farther off—and so it is with muscles, like those which bend the arm.

From the course of these remarks, I fear it will be thought that there is only one muscle concerned in bending the arm. The truth is, that in performing almost any motion of the body, or the parts of the body, a great number of the muscles are employed. In moving the hand alone, we use nearly forty; and in using the whole arm, not much less, I presume, than one hundred.

The curious reader may be anxious to know how the bent arm, or other limb, gets back again to its original position. Surely, he will say, the shrinking of the same muscles which bent it will not straighten it out again. No; there are other muscles on the back side of the arm, to draw it back when we wish; and so it is all over the body.

If you look on a skeleton, (see page 103 and the frontispiece,) you see how the bones at the joints project, and also how ragged the spine and many of the flat bones appear. Now the several hundred muscles of our frame fill up all these spaces, cover the ragged bones, and produce that smooth surface which we see on a healthy human body.

The change which takes place is something like that which would happen if we were to take some rather soft pliable substance, as hemp, and not only wind it about all the side pieces of timber in a wooden house frame, but extend it across from timber to timber, until the whole were so filled up and rounded as to appear like an even and regular surface, instead of a broken range of pieces of timber, with large vacancies between them.

About Fat.—But I must not leave the impression that the muscles and tendons perform all the "filling up" of the human frame, for it is not so. They are covered again by the skin, which is to be described in the next chapter. Nor is this quite all. There is in

most persons a small quantity of fat, intermixed with the muscles; and in some persons a great deal of it. This fat is found in the soft, white, cellular substance which is placed everywhere between the muscles, and the little bundles of which each is made up. You will now be able to understand and remember the meaning of the word *cellular*, for it signifies made up of little cells, something like honey-comb; and the fat is deposited in these cells. Only a small quantity of fat is necessary to health; and when it is found in unusually large quantities, in man and in other animals, it shows that they are diseased.

Reflections.—Thus we see that the great purposes which the muscles and tendons subserve are, the filling up and beautifying of the frame, and the motion of its parts and of the whole. We should be more helpless than the brutes are, if we had no muscles. Indeed, as we could not move a finger without them, we should be more miserable than any other animal; for all animals have muscles—even those which, like some shell-fish, hardly know enough to change their place.

But with the hundreds of muscles which we now possess, how multiplied are our motions! For you should recollect that not only the movements of the head, arms, hands, fingers, back, legs, toes, &c., are performed by these means, but also the movements of the very chest itself in breathing, unless, as is the case with some unwise or ignorant mothers, we confine the chest by tight clothing. More than all this, the curious processes of chewing and swallowing our food, and of speaking, singing, crying and laughing, are chiefly done—not without the aid of the teeth, it is true—by means of the muscles.

The muscles have other uses still, besides those of beauty and motion; but the reader is not prepared to understand what they are, till he knows more about the blood and the circulation. In describing the circulation of the blood, I shall be likely to make the matter plainer, by far—and with fewer words—than I could possibly do it in this chapter.

CHAPTER XI.

THE COVERING.—BOARDS AND SHINGLES.

The skin. Coloring of the skin. Change of color. The cuticle. Oil glands. Pores of the skin. Cleanliness. Hair and nails.

THE SKIN.—I have already told you what cellular membrane is. Now the first layer of the covering of the house I live in—for there are three of these layers—consists of this membrane, in pretty large quantity, and as it were pressed firmly together. It has a closely interwoven fibrous appearance, all the fibres crossing each other in every direction, like the felt of a hat; and it is strong and elastic. It is called the *cutis vera*, or real skin.

This membrane, or real skin, is principally composed of an almost endless number of small blood vessels, running along and crossing each other in nearly every direction, together with nerves equally numerous, intermingled

with them. The nerves, however, seem to be enlarged on the surface of this membrane, and to form little rows of eminences, or pimples. These are seen plainest on the tongue, and on the balls of the fingers; but they exist, in small size, all over us. You cannot prick the skin with the finest needle in the world, without hitting at least one nerve and one blood vessel. For there would be pain in doing so; and this always shows that a nerve is wounded. A very little blood will also flow, which shows that you have hit a blood vessel.

This is that which, in the case of the ox, deer and other animals, makes leather. In tanning, currying and dressing skins, the cellular layer just now described, the layer which remains to be described, and the paint, are all scraped off, and nothing remains but the true or real skin—the layer now under consideration.

I do not mean to say here, however, that leather consists of nothing but this skin, for tannin, as the chemists call it, which is extracted from the bark of the oak or other trees, combines with the raw hide, to make most kinds of leather; but I mean that no animal

substance goes to form the leather, except this single membrane.

Coloring of the Skin.—We come now to the color of the human body. For so far as I have already described the skin, the color is exactly alike in all people, black, red or white. Here, spread over the true skin—the part which forms the leather—on a thin, gauze-like membrane, called in books *rete mucosum*, and under the outside membrane not yet described, is a soft pulpy or jelly-like substance, containing the color. In the African, this pulpy substance is black; in the native American or Indian, it is red, or copper color; in the Asiatic it is yellow, and in the European, white. In mixed breeds—mulattoes, &c.—it is of course of the various colors which those mixtures exhibit.

I have sometimes been surprised to find how ignorant most people are on this subject of color. Some have never thought of it at all; others suppose that the whole mass of our bodies is darker or lighter, according to the indication of our faces; others suppose the color is in the blood; and others still that it is

in the true skin, or the part which forms the leather. But we see that none of these are right—that the skin itself, properly so called, is alike in the whole human race; that is, it would form leather of the same color in all; and that the color might be removed, though not without much pain, leaving one individual as white and as dark as another.

What good this color does is, I believe, unknown; or why all mankind could not just as well have been left wholly without it, and all have been really flesh-colored. In some parts of the skin, in the European race, there seems to be but very little of it. It is only on the cheek, and perhaps the lips, that the color seems to differ much from that of the real skin itself.

There have been many conjectures about the uses of this coloring matter, but there is very little true knowledge abroad concerning it. We know, indeed, that a dark skin, as it allows the heat of the body to escape more rapidly than a light one, renders a person cooler in hot weather, in hot climates; but it would be difficult to believe that this is the principal reason for its existence.

Change of Color.—There is one curious fact which deserves to be mentioned in this place. It is that the coloring matter, in some persons, has been known to change. There have been several negroes, and I believe one or two Indians, in whom spots of a chalky white have appeared on their limbs, which enlarged and spread until the whole body became white.

It is not at all strange for other buildings to fade; but for the human habitation to lose its color, imbedded as the paint is under a hard, tough membrane, seems rather unaccountable. But it is the result, no doubt, of disease.

The Cuticle.—I observed that the skin, as it is called, of the human body, consists of three layers. I have described two of them, and the mention of the membrane which covers this paint or pigment reminds me that it is time to describe the third.

This membrane—the cuticle—which answers to the clapboards, shingles or tiles of a wooden building, is constructed almost exactly like the latter. Or perhaps it would be equally correct to say, that it is formed like the scales

of fishes. For anatomists who have viewed it with glasses which magnify greatly, say that, thin as it appears to the naked eye, such is its real structure.

The cuticle is the part which rises when the skin is blistered. If you examine it when it is thus raised, however, you will be a little disappointed in regard to its structure; for it is then so soaked with the water of the blister, and so much thickened, that it does not appear at all natural. In its healthy state, it is scarcely a fiftieth part as thick as the covering of a blister; besides which, it is transparent, or nearly so. If it were not, you could not see the coloring matter under it so plainly.

The cuticle is not equally thick throughout its whole extent; for even in young children and infants, the palms of the hands and soles of the feet are tougher than elsewhere; and going barefooted many years together renders the feet almost as tough as leather.

You will get the best idea of the cuticle which the naked eye can give you, by examining it when you have accidentally grazed off small portions of it. These grazed places soon heal, however, if we are temperate and correct

in all our habits; though I have known an old man, who was intemperate, to have a sore and lame leg almost a year, in consequence of a slight wound that would have healed in a week, had he been temperate.

The most surprising fact in regard to the cuticle is, its power of being reproduced, or of growing again. If grazed off, or if it peels off, after a blister or swelling, a new cuticle appears with so much rapidity that one would be tempted to think it was already formed under the old one, as the new teeth are under the old ones, which they push out. But it is not so. The new cuticle never grows till the old one is either separated or dead.

The coloring matter, if destroyed, grows or appears again, almost as soon as the cuticle does; but the real skin, which I described just now, if once destroyed, never grows again. This is the reason why scars are produced on us. The loss of the cuticle, or the coloring matter, never causes scars; but that of the real skin always does. It is true, its place is sometimes filled up with a substance which strongly resembles skin, and which answers the purpose; but it never becomes real skin.

Oil Glands.—All animal frames seem to require frequent lubricating, or oiling; and, in some of the feathered tribes, this is effected by means of the beak. They have a little gland, as it is called, which furnishes them with oil. This oil they press out with their bills, and then apply it to their feathers, which overlap each other like shingles, that they may the better shed the rain.

But most other animals, instead of having the oil in a single bag or gland, have it in numerous little receptacles, almost too small to be seen by the naked eye, and deeply imbedded in the skin. They are very thick in the skin of the sheep, and hence the wool of healthy sheep is always quite oily. They are numerous, too, about the roots of the hair of most animals; and hence it is that the hair—even the human hair—in a state of health, appears more or less oily.

This oil for the hair appears to be furnished by a multitude of little bags or glands lying near its roots, somewhat resembling a bottle in their shape, from the open neck of which oozes the oil. In man, the hair of whose body is generally thin, this oil is in very small

quantity, and is not very important to health. There are many of these little glands in other parts of the body, as well as at the roots of the hair. They are found in great abundance wherever there is much exposure to the air, or much friction, as in the nose, ears, groins, arm-pits, &c. They are called *sebaceous glands*, or *follicles.*

Those nations—and some such there have been and still are—who put on an additional quantity of oil, are far from being the most healthy. In fact, if the human skin is not often washed, to get rid even of its natural oil, it becomes a source of disease.

Pores of the Skin.—Besides the mouths of these little oil glands, many anatomists have considered the skin—and the cuticle of course—as pierced with little openings called pores, almost innumerable. Some have reckoned them at 1,000,000 to every square inch. Others, however, deny all this. But one thing is very certain, which is, that what we call sweat, or the accumulated perspiration of the body, when it becomes abundant, is constantly escaping through the skin and its cuti-

cle, in the form of a thick mist or fog, as we may see by holding a bright mirror close to it, which will immediately become tarnished. Or if we sit where the sun shines across us, upon a wall, we can see the shadow of the mist which ascends from us, rising like a sheet of thin smoke upon the wall.

Cleanliness.—It is of less consequence to people to know how this moisture escapes, than to know the fact that it does so, and to know also that if this constant *perspiration*—for that is its name—is checked for any considerable time, mischief in the form of colds, fevers, rheumatisms and consumptions may ensue. Great mischief may also follow, if this perspiration is checked by neglect of cleanliness.

There are also other offices performed by the skin which are curious, but I will mention no more of them now. The more you understand the structure of this part of the frame, the more you will see how important it is that it should be kept clean by washing, every day we live. And yet how many there are, who hardly wash it at all, except perhaps their

face and hands! Such persons are not fit to be entrusted with a habitation so fearfully and wonderfully made. In truth, they are not usually so long entrusted with it as others. The great Architect usually turns them out many years earlier than he would, if they took care of it; and in the case of cholera or malignant fever, sometimes thrusts them out with apparent, though deserved violence.

The Hair and Nails.—This is the proper place for saying something about the hair and nails; for these, though not skin, are closely connected with it, and even fitted into it. The hair appears to be the proper covering for the head; but more pains are necessary to comb it and keep it clean than are commonly used; and for this and several other reasons, it is apt to become sickly and diseased, and to fall off.

In some parts of Europe, as among the peasants of Poland and Hungary, who greatly neglect cleanliness, and are addicted to other filthy and bad habits, the hair becomes closely matted together, and a terrible disease ensues, called *plica polonica*. But in all countries,

not only the hair, but the health in general, suffers more or less, if we long neglect the cleanliness of any part of our bodies.

As to the nails, I can only say that they are intended to brace or support the balls of the fingers, so that we can use them the better in examining bodies by the sense of touch. Hence one reason why they should not be pared too closely ; and hence, too, the reason why, when they are pared too closely, the ends of the fingers often become more or less crooked.

CHAPTER XII.

THE COVERING.—THE WINDOWS.

General remarks. The human eye. Situation of the eye. Muscles of the eye. Coats of the eye. Optic nerve. The tears. The eyelids. The eyebrows The eyelashes. Reflections.

General Remarks.—Before glass was invented, the windows of dwelling houses were small, and made in different ways. In summer, they often consisted of a mere hole in the side of the building. In the eastern houses there were no windows of any kind in *front*, or towards their neighbors ; and in China, this is the custom to the present day.

In winter, these holes or windows were closed up with something which would partially exclude the cold, the rain and the snow. In some countries of Asia, and in ancient Britain, they used oiled paper for tnis purpose. In France, besides oiled paper, they used talc

or isinglass, white horn, and thinly shaved leather. In ancient Rome, the rich sometimes used very precious stones. Those in their bathing houses were often of agate or marble. The Chinese used a very fine cloth, covered with a shining varnish; and, afterwards, split oyster shells. They had also the art of working out the horns of animals into large and thin plates, which they used in the place of glass for their windows.

The first windows of common glass, that is, sand, potash, &c. melted together and formed into plates, were made in the time of Constantine the Great, in the fourth century after Christ; though it appears from later inquiries, that glass windows were known in Rome long before that time. But it was not till the fifteenth or sixteenth century, that glass was brought into common and general use.

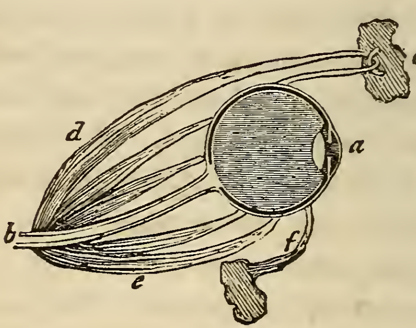
The Human Eye.—The windows of the human frame are made neither of paper, isinglass, agate, marble, horn, leather, cloth, oyster shells or common glass. Nor are they confined to the back part of the house, like those of some eastern nations. Nor are they

very large or numerous. There are but two of them, and those are rather small in size. They are set in the front part of the house, in the cupola.

Both of them open or shut—rise and fall, have the curtains drawn or removed, and the blinds opened or closed—at the same instant or separately, just as required. Most windows are made to be raised only, that is, moved, in one direction; but these move every way, and with the greatest ease and rapidity. It is done by means of pulleys, &c. The curtains may be drawn or removed almost with the swiftness of lightning, and hundreds of times in a minute.

SITUATION OF THE EYE.—The human eye is almost as round as an apple, though not quite; for it projects a little at the fore part. In an adult person, it is not more than an inch in diameter, and lies deep in a cavity in the skull. It is not *fixed*, like the eyes of some animals, but can be made to roll about, upward, downward and sideways. For this purpose, it does not adhere closely to the bone, but lies on a soft bed of fatty substance,

and has many muscles or cords fastened to the sides and back part of it, as you see in the engraving.



If the eye of a dead person was to be cut in two in the middle, from top to bottom, with the handle of the knife held forwards, and the point towards the back side of the head, a side view of one of these halves might be supposed to look like the engraving. A large whitish cord, which you see running from *b* to the back side of the eye, comes from the brain, and is called the optic nerve. The rest of the cords between *d* and *e* are muscles, or little bundles of flesh; and they become tendons, or hard whitish cords, of very great delicacy, at the smaller part, where

they are fastened to the eye. The tendon of the upper one goes round a little piece of bone like a hook, as you find at *c*. The lower one, *f*, is also fastened in a very ingenious manner.

The tendon that passes round a piece of the bone of the forehead, is fastened to the very top of the eyeball. Now it is easy to see that if the upper muscle at *d* should contract or shrink, it would operate just as if it were a rope, and somebody pulled it;—that is to say, it would pull the top of the eyeball forward, and make the fore part, at *a*, turn downwards, so that a person might look towards his feet.

MUSCLES OF THE EYE.—The eyeball is moved by six muscles, four *straight* and two *oblique* ones. The straight ones are placed, one on each side of the ball; one at top, and one at bottom. They begin at the sides of the hole into the skull at the back part of the socket of the eye, through which the optic nerve (eye nerve) passes to the brain.

One of the oblique muscles rises from the same place with the others; but the other

comes from the fore part of the eye. The four straight ones (which can be seen in the plate) move the eyeball to either side, upwards or downwards, as may be wished, and according to which of them is employed; and the oblique muscles, acting separately, also move the ball to either side. When the straight muscles all act together, they draw the eyeball deep into the socket; and when the others act together, they draw it forwards again

Coats of the Eye.—The eye is a large hollow sack, containing a clear but thick liquid, a large part of which is not unlike the white of an egg. The covering of the eye consists of several coats or layers.

The outside, or *sclerotic* coat, as it is called, can be seen in the engraving. It is very thick, and a small portion of it at the fore part is wanting. In this vacancy or opening is set the *cornea*, a piece of membrane which is transparent—that is, can be seen through like glass. This transparent part you will find near *a*. It is placed in the sclerotica, as a crystal is set in a watch; or, if we compare

the eye to a window, just as a pane of glass is set in the frame; with this difference, however, that a pane of glass is seldom round, while the cornea is as round as a dollar. It also stands out from the eye, like the crystals of most watches; and through it the rays of light enter the eye, to pass to the back part of it. What we call the white of the eye is the sclerotica, or window frame, as far as we can see it, surrounding the cornea.

The *tunica sclerotica*, or sclerotic coat of the eye, is lined by another thin coat, called the *choroides*. The internal surface of the choroides is covered all over, except at the back part, where the optic nerve enters, with a thin, sooty kind of black paste, called by anatomists the *pigmentum nigrum*, which signifies black pigment. You can see this paint represented very fairly in the engraving; and as this is spread over the choroides, and the choroides only lines the sclerotica, and does not extend to the cornea, you can easily see where the latter begins. The use of this black pigment is to absorb or drink up the rays of light, after they have performed the office for which they are intended.

Where the sclerotica and cornea join, a kind of circular membrane or curtain runs inwards, and is represented in the cut by two white lines approaching each other, but not quite coming together. When we look at the eye of a living person, this curtain is sometimes light blue; in other persons it is gray, hazel or black. When this curtain, called the *iris*, is blue, the person is said to have blue eyes; when black, he is said to have black eyes, &c.

The circular hole, in the middle of the iris, is called the *pupil* of the eye. It is larger or smaller in proportion as the iris is shrunk more or less; for the iris will shrink or contract, a little like the muscles. The greater the light before the eye, the smaller is the pupil. When we are in the dark, it is very large, as if the iris shrunk back in order to let as many rays of light pass through the pupil, to the optic nerve, at the back part of the eye, as possible.

The greater part of the rest of the eyeball consists of a substance which I told you had some resemblance to the white of an egg, or that ropy but clear fluid in which the yolk

swims. Anatomists, however, say that the greater part of it resembles melted glass, which I suppose few of you have seen; but as we have called the eye a window, the comparison is a very happy one.

The edges of the iris or curtain, like a partition, divide this liquor into two parcels, connected only at the pupil. The part of it which is before the iris is called the *aqueous humor;* and that which is behind it, and which is many times the largest, the *vitreous humor.*

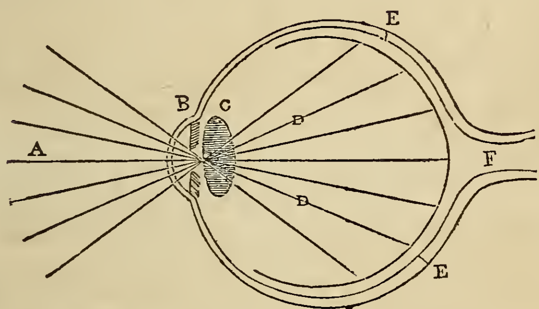
Just at the back of the iris, exactly behind the pupil, is a small body, clear and transparent, like the rest of the vitreous humor, but much harder, and imbedded in its midst, without ever getting out of its place. It is called the *crystalline lens.* It is rounded or convex on both sides, and resembles two watch crystals, with their hollow or concave sides put together, only that there is no hollow in the middle of it. It may be as large as the kernel of a hazel nut.

The lens is represented in the engraving by a light spot, which you cannot fail to distinguish, near the fore part of the eye.

There is a disease of the eye, in which this lens turns whitish; and as the rays of light can no longer pass through it, the person becomes blind. The only way to cure it is for the surgeon to pass a slender needle through the side of the eye, and push this hard, dry, dead body downwards, or to one side. This is often successful, and the process is attended with less pain than the extraction of a tooth. Sometimes, also, the surgeon takes this diseased lens, or cataract, quite out of the eye.

Optic Nerve.—The optic nerve, which I mentioned as entering at the back part of the eye, expands or spreads itself as it enters, over the whole choroides; and this expansion is called the *retina*. This, though it is the end of the optic nerve, and of course a part of it, is yet different from it in appearance, being more tender, pulpy and gray than the body of the nerve itself. The rays of light, entering from all directions, in passing through the eye, strike first upon the cornea, then pass through the aqueous humor, (part of which lies before, and part behind the pupil,)

and then enter the crystalline lens. Having arrived there, the rays diverge as from a centre towards its circumference; and after going through the vitreous humor, strike on the retina; and it is here that what we call sight is effected. Here is a plate to illustrate the mechanism of vision.



A, rays of light from all parts. B, cornea through which they pass. C, crystalline lens, where they suffer refraction; that is, are crossed or bent out of their course. D, diverging rays. E E, retina, upon which the picture is formed. F, optic nerve.

The image or picture of every object which is before the eye is formed on the retina, inverted, that is, bottom upwards. Thus, if I am looking at a house or tree, there is a kind of shadow or image of that house or tree on the retina of my eye, with the bottom up-

ward. Why everything we look at does not appear to us inverted, rather than with the right end upwards, is not known.

There are many people who cannot see objects clearly, unless they are very close to the eye. Such persons are said to be *short* or *near sighted.* This is because the cornea—the crystal which is set by the Creator in the fore part of the eye—is too round, or convex; though it is sometimes because the crystalline lens is also too convex. In either case, the evil is partly obviated by wearing spectacles which are concave, that is, thinner at their centre than at their circumference.

Other people are *long sighted*—the consequence of having the cornea of the eye too flat. This is almost always the case with people as they grow old. The evil is remedied, in part, at least, by using convex glasses,—exactly the contrary course to that recommended in the former case. Much might be added on this subject, which would be interesting, but we have not room for it in a work like this; nor is it absolutely necessary to the very young student.

The Tears.—From a small gland, not unlike the gland which furnishes the saliva, or spittle, only much smaller, over the top of each eye, just within the socket, flows a small quantity of a clear liquid, and, by means of the eyelids, operates as a moist cloth would do, passed over a glass window. This liquid is carried over the whole surface of the eye, and keeps it constantly moist and clean. The superfluous liquid is then carried off through a very narrow passage, which descends from the inner corner of the eye, and is conveyed by a pipe or duct into the nose.

The little gland over the eye is called the *lachrymal gland;* the liquor which it furnishes to wash the eye is called the tears; and the tube through which the tears escape into the nose is called the *lachrymal duct.*

If this duct gets permanently stopped, as sometimes happens, the tears overflow the eye, and run down on the outside of the cheek, which causes much trouble. To remedy this evil, the surgeon is sometimes obliged to fix an artificial tube in such a manner as to convey the fluid into the nose, to be carried off as it should be.

THE EYELIDS.—The eyelids are to guard the tender eye from injury in various ways.

One of their uses is to keep off the too strong light of the sun. If our eyelids were cut off, if it did no other harm, I am sure we should soon become blind. Those people who let the full blaze of a candle, or lamp, or bright fire, shine on their eyes, run a great risk of injuring their sight; but they are sometimes a great many years in finishing the work of making themselves wholly blind.

Besides veiling the eyes during sleep, another use of the eyelids is to ward off small bodies from the eyes, as sticks, chips, stones, &c. The power of the eye is wonderful in this respect. It will sometimes close so suddenly as to shut out an object which could hardly have been seen, just as if it felt it coming before it arrived. It does not always close quick enough, however; for blacksmiths, stone-cutters, cutlers, &c. sometimes have their eyes more or less injured.

THE EYEBROWS AND EYELASHES.—The eyebrows serve as a sort of defence to the eyes, by catching a part of the dust that would

otherwise fall into them. Perhaps they may have other uses than this; but I have not room to enlarge. I should like to describe the eyelashes, and mention their uses, and also speak of several other membranes, vessels, &c., connected with this wonderful organ, but the limits of a work like this forbid. I can only say that besides contributing to the beauty of the countenance, both the eyelids and eyelashes lend their aid in keeping off too strong a light, as well as in defending the tender organ beneath from injury.

Reflections.—I must not close this chapter without noticing the place in which the eye is situated. Some animals, as the snake, tortoise, &c., have the eyes set in the side, or rather in the upper part of the head, precisely where they are wanted; for they have no occasion to look downward. In general, those animals that cannot move the eye without moving the whole body, have this organ more prominent, and more to the side.

But man, without moving his body at all, can move his head in such a manner that though the eyes are fixed in the front part of

the head, and in a deep socket, he can yet look in every possible direction. All things considered, his eyes are as happily placed as those of any other known animal; and they are much better guarded from injury. Their deep bony socket, the high ridge around it, the eyebrows, the eyelids, the eyelashes, and lastly, reason to direct us, and enable us to avoid danger, all conspire to guard the "apple of the eye," as it has been called, with great care; and, in this country, it is comparatively seldom that we meet with a person, young or old, who has not both eyes perfect.

CHAPTER XIII.

THE COVERING.—THE DOORS.

Description of the ear, externally and internally. Description of the nose. The mouth.

The doors of the house I live in are the mouth, ears, nose, &c. These I call doors for reasons which have already been given, and for others which will presently be seen.

The Ear.—Some account of this has been given in treating of the bones. The reader has already been told that it is made for the admission of sound; that if there were no ear, we could hear no sounds, and that a part of this curious organ lies deep in the bones of the head.

There are, in fact, two great divisions of the human ear—the external and the internal. The external ear is what we see in the living

individual, consisting of a semi-circular portion, spread out, the shape of which everybody knows, and a passage in the middle, leading into the head.

The external ear, which we see, is made of gristle or cartilage, covered with the skin. It is concave, for the collection of sound. Such is the curious structure of the eye, that the rays of light, from all directions, are collected into a very small point at the back part of it; and in like manner, such is the structure of the external ear, that sound is collected by it towards the passage, in the centre.

This passage is lined by a membrane like the skin, except that it is a little thinner, the oil glands more numerous, and the oil very bitter. What is called the ear-wax is this oil, dried, and accumulated in large quantities. Sometimes it has been known to accumulate in such hard masses, and of such a size, as to make people deaf, by obstructing the passage of sound. There was lately a case of the kind in this neighborhood. Both ears were thus obstructed, but one was much worse off than the other.

This oil or wax is supposed to have been made bitter, to keep flies and other insects from getting into the ear; for these insects dislike bitter substances. There is, however, less danger from having insects get into the ear than is commonly supposed; for when the ear drum, or membrane of the tympanum, of which I have spoken in another place, is not ruptured, neither insects nor anything else can get into the head more than three quarters of an inch, and could easily be washed out. Still, they might produce some irritation, and they are therefore excluded by the means spoken of.

If, however, the ears are washed out well every day, and especially if they are often syringed out with weak soap suds and water, we shall seldom have trouble, either from the collection of wax or from insects. Cleanliness is very important, not only in the case of the ear, but of all parts of the body.

Beyond the drum is a chamber, called by anatomists the cavity of the tympanum. In this cavity are the little bones which I have formerly described. Here also a small passage commences, which terminates near the back

part of the nostrils, called the *eustachian tube.* The use of this passage, from the inside of the mouth to the internal ear, is not very well known; but it is believed to be intended, in part, for the purpose of letting in air, in order that the pressure on both sides of the drum may be alike.

Some suppose that it enables us to hear a little through the mouth; but this is not probable. If we hear at all through the mouth, it is in a degree scarcely worth mentioning.

Near the hinder part of this cavity of the tympanum, there is also an opening into a collection of cells in the bone. The part of the head in which these cells are situated may be found quite prominent behind the ear. The use of the cells is not very well known.

Though the ear is to be considered a door of the human habitation, the passage into it, as we have seen, is usually closed by the ear drum. The door-way for everything except sound, therefore, would be more properly through the mouth.

Sometimes—we know not how—the drum membrane gets broken. There have been

men, for example, who could force tobacco smoke, held in their mouth, out at their ears. This proves that the membrane in question had a hole in it. I do not know that such a breach affects the hearing very much. It is true it requires us to be more cautious what we get into our ears; for if substances go beyond the ear drum quite into the cavity of the tympanum, they will produce inflammation; and in the end, perhaps, cause deafness or death.

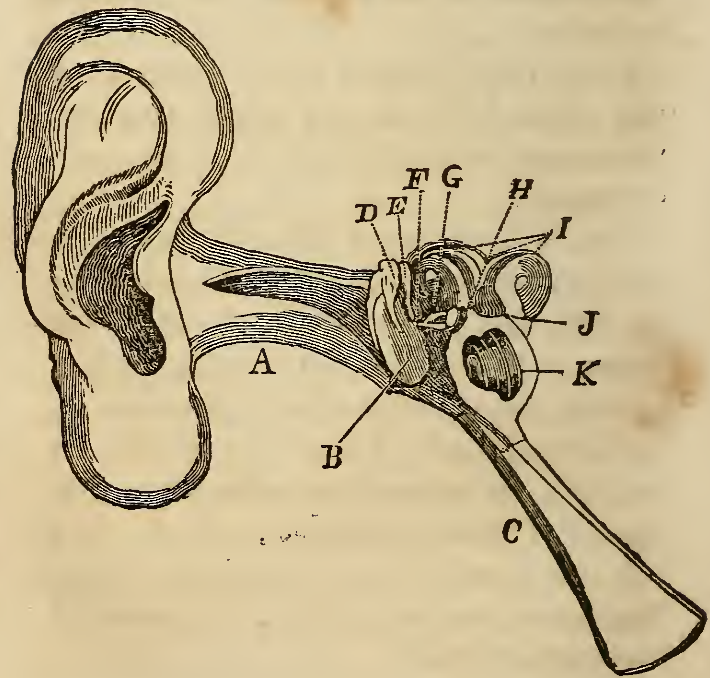
I wish I had room to tell you more about this cavity of the ear, and indeed about the whole organ of hearing; for it is a very curious organ.

But all I can say, which will probably be useful to you at present, is a few words about the *labyrinth*. This is a large cavity, still deeper in the head than the foregoing; and, if possible, still more curious in its structure.

The middle part of the cavity is called the *vestibule*. It is somewhat oval in shape. At one end of it are three tubes, each of which is so bent or curved as to form almost a circle. They open into the vestibule, and are called *semi-circular canals*.

At the other end of the vestibule is a tube of a conical shape, but resembling, on its outside, the shell of a snail. It is called the *cochlea.* This also opens into the vestibule.

The little bones of the ear are connected with the ear drum on one side, and with the parts of the labyrinth just described on the other. The labyrinth, in all its parts, is most intimately connected with the brain; and some



of these very parts themselves seem almost like brain. They contain a tremulous jelly-like substance, among which those branches of the brain which we call the nerves of the ear are very thickly interspersed.

On the preceding page is an engraving of the ear, both external and internal.

In this engraving, A represents the tube or passage leading to the ear drum; B, the ear drum, or tympanum; C, the passage from the ear to the throat; D E F G, the little bones of the ear; I, the semi-circular canals in the ear; J, the vestibule, and K, the cochlea. H refers to a little opening.

What always strikes me most, in relation to the human ear, is the singularly careful manner in which the nerve of hearing—the auditory nerve—is distributed in the various parts of the labyrinth. Its various branches are spread upon a soft, pulpy substance, which serves as a sort of cushion, and is almost as tremulous as a mass of jelly or fluid. How much there is of divine wisdom displayed in placing this soft, tender mass, and especially the tender and delicate extremities of the nerve, in a curious box of the hardest bone, yet connected

with the external world in such a way that the softest whisper, as well as the loudest thunder and the heaviest artillery, will reach it and produce sensation! The optic nerve, in the back part of the eye, is little better secured from injury than this auditory nerve.

It may not be out of place just to remark, here, that the same almighty wisdom and goodness which are shown in the construction of the human eye and ear, are displayed in the eyes and ears of many other animals. Those which pursue their prey by night, and need to be guided much by the sense of hearing, have large muscles which enable them to move their ears, especially to erect them. Savages, and some civilized men, have this power in a slight degree, but in a slight degree only. In animals of the whale kind, and most others which dive in the water, a valve is placed within the aperture of the external ear, to moderate the pressure of the water upon the drum—besides which, the passage into the ear is very crooked. The study of the structure of beasts, birds and fishes, is exceedingly interesting, as well as important.

The Nose.—This is a more important door of the human habitation than many suppose. All or nearly all animal and vegetable bodies are constantly sending off small particles, the quality of which, when they are received at the nose, in its natural state, can in general be easily detected.

This is undoubtedly one great purpose of this organ, and especially of its curious internal structure. For in order that we may detect the nature of the bodies whose particles the air is constantly full of, the inside of this organ of smell is very extensive.

1. The bones, in some places, project into the nose, like large but irregular shelves.

2. There is a hollow cavity in each cheek bone, which will hold about half an ounce, and which has a communication with the inside of the nose.

3. There are also cavities in the forehead, at the top of the nose, between the eyes, which communicate, in like manner, with the cavity of the nose.

Over this extensive internal surface, viz., the whole inside of the nose, the surface of the projections or shelves, and the inside of

the cavities in the cheek bone and forehead, a fine, delicate membrane is spread; and over a great part of this membrane, little nerves are distributed, by means of which we smell. They are branches of what is called the *olfactory nerve.* Here I wish to say again, once for all, that we cannot have feeling or sensation, in the eye, in the ear, in the nose, or anywhere else, without the aid of these little branches of the brain, called nerves And it aids us in smelling, to have the parti cles of bodies in the air we breathe diffused over such a very large surface.

I have more than intimated that in a *natural* state of the organ of smell, it could detect all substances which were likely to be injurious. This, though very probable, cannot be fully proved. Other animals, we know, can in general tell what will injure them, by its smell; and we can do so in regard to very many things; and they can oftenest do this, whose smell is most perfect. There is, therefore, great reason for believing that, did we not early accustom our noses to the smell of strange mixtures—for, to say nothing of snuff, tobacco, &c., almost everything we take is

some unnatural if not unwholesome mixture—we could distinguish by their smell those things which are hurtful—at least in most instances.

However this may be, one thing is certain; which is, that trained as we now are, in regard to eating and drinking, it would be very strange indeed if the sense of smell should long retain its original integrity.

The extensive cavity of the nose has another use, besides favoring the sense of smell. If we hold our nose, and speak or sing, we find the sound greatly altered, and rendered quite disagreeable. One intention of the nose, therefore, like those hollow boxes in some ancient buildings, placed over the head of the speaker, and called *sounding* boxes, is to modify and improve the voice.

How poorly the nose sometimes answers this purpose, is best seen in those individuals who dry up the nasal membrane with snuff, or make the nose a chimney for tobacco smoke—purposes for which we may be very sure they were never designed by the Creator, and to which well-informed people would not be apt to apply them.

The Mouth.—This is, in many respects, the most important door of the human frame. For if the nose should cease to perform its office, we could supply its place, in some measure, by the eye, the ear, and the touch. The same is true of the ear, and even of the eye. But if the mouth were to fail—if this door were closed forever—there is no substitute. We may indeed receive a part of the supplies necessary to our existence, (I mean air,) through the nose; but a far greater part could not be received even in this way; and our frames would soon decay, and mingle with their kindred dust.

I have never known but one instance in which any kind of substitute for the mouth was provided. Several years ago, a young Canadian by the name of Alexis St. Martin was wounded, in the army, by a ball, which shot away a part of the flesh of the side and stomach. When he recovered, an opening was left somewhat like the mouth of a purse, directly from his left side into his stomach. So complete was this artificial mouth, that though it was very tender, food and drink could be introduced into it through a pipe;

and if care were used, it could be done without pain. The contents of the stomach—the fluid contents at least—which had been swallowed by the mouth, could also be taken out at any time.

I have seen Alexis once myself; and have witnessed what I state. But this is perhaps a solitary case. I do not know that any other case of the kind ever existed, or ever will exist again.

The particular structure of the mouth—curious as it is—is so well known that it does not seem to require a particular description, under this head. When I come to speak of the apartments, and especially of the furniture and employments of the house I live in, I shall have occasion to say more about it. It was only necessary to mention it here as a part of the covering, and for the sake of method.

CHAPTER XIV.

APARTMENTS AND FURNITURE.

General remarks. The external ear. Chambers of the nose. The mouth, internally. The salivary glands. Passages to the ear. The chest. Cavity of the lungs. The voice. The food pipe. The stomach. The intestines. Gall bladder, &c. The abdomen. The apartment of the circulation. Chambers of the brain. Nerves.

General Remarks.—There are two kinds of apartments in the house of the soul. One of these is connected with outside doors; the other is not. Both are numerous, and both are important. I will begin with a description of the former; and occasionally speak, as I go along, of some of the latter.

In many houses a broad space or hall extends through from the door in front to the back side of the building. This space is not always either uniform or regular Sometimes

--and indeed usually—if the house has more than one story, it contains a stairway; and sometimes it includes a closet or a room for other purposes. Doors also in the sides of this hall connect it with other apartments.

Now the house I live in is constructed very much on the same general plan, except that, as I told you in reference to the frame, there is no *square* work about it. The beauty of the internal parts of a common dwelling house depends very much on its straight lines, upright walls, and horizontal floors and ceilings; but the beauty of the habitation of the human soul consists, on the contrary, in curved lines. Not an apartment can be found, in good order, in which you can trace a single straight line.

There is one more essential and important difference. The rooms in many dwellings are often partly or wholly empty; or at least there is nothing in them except a small quantity of furniture and air. But except a few very small and not very important apartments, all the rooms of the house I live in are completely filled. Such a thing as empty space is hardly known there. The furniture, or whatever is

in them, at all times completely fills them; for when anything is removed from them, their walls are accustomed to shrink accordingly; and when anything is introduced into them, these walls have the power of gradually yielding so as greatly to increase the capacity of the apartments.

It is true, that the furniture, &c., in each room, does not so entirely fill it as not to leave place for air; for as I have already said, all the kind of rooms of which I am now treating, have communication with the open air, in such a way that the air, in small quantity, can, and probably does reach them; and much more of it would reach them, were they not so closely filled as to prevent its admittance.

But it is time for me to speak of these apartments with more particularity. I must here tell you that all the cavities, or passages in the human body which open to the air, such as the ears, nose, mouth, &c., are lined with a membrane almost exactly like the skin, only thinner. It has its thick layer, or real skin, on a thin cellular layer; then its soft thin layer of pigment or paint, if this has any existence beyond the commencement of

the openings, say at the edge of the lips;* then, and lastly, its cuticle.

This membrane is not called skin, however, except on the surface. Its usual name is *mucous membrane*, because it everywhere *secretes*, on its surface, more or less of a substance which is called mucus.

External Ear.—The passage into the ear, as we have already seen, is lined with this membrane. But this passage or cavity is so small that it can hardly be called an apartment, and it has been already sufficiently described. The cavities connected with the nose are of much more consequence.

Chambers of the Nose.—These, as we have seen, are—1. The hollow but very irregular passage of the nose itself. 2. The cavity in each cheek bone. 3. The cavity in the forehead, or on each side of the root of the nose. All these cavities are *real* cavities; for

* Anatomists are not agreed on this point. The general opinion is, that this membrane which contains the color does not exist at all in the internal cavities of the body.

they are situated in hollows in the bones, and therefore their sides cannot fall together and close up the space.

All these cavities, moreover, become in some cases the seat of painful diseases. The nose is subject to the polypus—a pear-shaped swelling with a narrow neck. This sometimes renders our breathing difficult; and if not extracted, has been known to go farther, and become the means of destroying life. Even if it is extracted, it is very apt to grow again.

Painful diseases also occasionally arise in the cavity of the cheek. These are sometimes mistaken for tooth-ache. The extraction of the tooth which appears to cause the pain, unless its roots extend through, quite into the cavity, affords, in such cases, no permanent relief.

Some kinds of headache probably have their seat in the hollows of the frontal or forehead bone, near the root of the nose. A very common disease in sheep, is known to be produced by worms in these hollows, which are produced by some of the species of flies depositing their eggs up the nose of these animals, where they are hatched by the heat. The

dull, heavy pain so often felt over the eyes, especially when we have what is called a cold in the head, may be owing to a slight inflammation of the membranes of this cavity.

People ought to be careful about smelling things which give them much pain. Probably the use of most of our smelling bottles is injurious, in the end, to the delicate lining of all these "rooms" connected with the nose. Snuff certainly is, and so is the smoking of tobacco and cigars and the use of opium—so common in some countries.

THE MOUTH, INTERNALLY.—The mouth, of itself, is one of the apartments of the human body, and a very curious apartment too. When I spoke of it as one of the doors, I referred principally to the aperture formed by a cleft of the lips, or the external mouth; and not the *internal* or more important part.

In this chamber—the entrance chamber of the front door—we find the teeth, the tongue, the palate, and several little glands. This entrance chamber is larger than the hall or space beyond it. Doors also open from it into several other apartments.

THE SALIVARY GLANDS.—The first of these doors are very small. They are on the inside of each cheek, nearly opposite to the smaller double teeth. They lead through a very narrow passage, scarcely bigger than a straw, to the chambers where a large part of the saliva or spittle is secreted or made, which is just back of the hindermost part of the jaw-bone, and just below the ear.

These chambers are neither large nor regular. Indeed, they scarcely deserve the name of chambers, any more than do those in the upper part of the socket of the eye, of which I have already spoken, and which secrete the tears.

Under the tongue and partly before it, are the doors of passages, still shorter and smaller than those I have just mentioned, and leading to apartments of still less importance. They are, however, for the same purpose; that of secreting the saliva.

PASSAGES TO THE EAR.—Farther on, in the upper and back part of the mouth, are two doors of considerable size, communicating with the chambers of the nose; and in the same region

begin the passages which lead to the middle cavity of the ear, which has already been mentioned, called the tympanum. I have said enough about these various apartments in another place.

A little behind the roof of the tongue, is an opening, whose structure has a strong resemblance to what is usually called a *trap door.* It leads to the lungs or breathing apparatus, occupying a very large upper apartment of the body. This is one of the most curious parts of the human system. No real gate or door, set on hinges, and guarded by an active and intelligent porter, could better answer its intended purpose.

I have said that there is a strong resemblance here to a trap door. The passage to the lungs, where it commences, is a mere slit; though it is true it very soon becomes larger. Over this slit is placed a lid or flap, not unlike the tongue in shape, but of course much smaller, which fits to the opening as exactly as ever a trap door was fitted to its frame.

It is not usually shut, however, except when we attempt to swallow something. Then the substance we swallow and the motion of swal-

lowing, press it down and close it tightly. And it is well that it is so; for if it were not, the substances which we swallow would often drop into the passage to which this trap door opens, and cause us great pain, and sometimes disease. A mere crum of bread will produce immense pain in "going down the wrong way," as we call it.

The Chest.—Beyond the door, the passage greatly enlarges, and proceeds downwards into the chest—the large apartment which I have just mentioned. This apartment is one of the largest in the house I live in, and nearly fills the upper story. It is one of the kind which have no outer doors, neither is it connected with any other cavity or apartment. It is supported on all sides by strong bony walls; the breast bone in front, the back bone behind, and the ribs at the sides. Above, at the fore part of the neck, it is of course less guarded with bone; and at the bottom there are no bones at all. It is separated from the apartments of the second or lower story, by a strong membrane called the *diaphragm* or midriff.

Cavity of the Lungs.—The trap door, of which I have spoken, does not lead directly into this large apartment, but only into a bag or sack, called the lungs, which lies in it, and fills it; and is divided into two portions, one on the right side and the other on the left. The passage from the door-way at the top of the throat into the lungs, is at first considerably large, and may be both felt and seen at the top of the throat. It appears, at first view, to be a long bony tube, but it is not so. It is made of firm cartilage, almost as hard as bone. As soon, however, as it gets fairly within the cavity of the chest, it ceases to be cartilage, and becomes nothing more than common membrane.

The passage now divides into two, like the trunk of a tree when it divides into two branches. One of these smaller passages goes to the right side of the lungs, the other to the left. Soon each of these parts divide again; then those branches subdivide; and it is not long before the branches become as numerous as the limbs of the thickest tree. And what makes them appear thicker than they really are, is the ten thousand little cells, like innu-

merable small berries among the limbs of a tree or shrub, which are everywhere interspersed; for every one of the smallest passages, into which the larger passages lead, terminates in a little hollow cell. Some of the cells are indeed larger than others, but they are all very minute, so much so that many anatomists formerly doubted their existence.

The most correct resemblance of these passages and cells or little rooms would, in my opinion, be a very thick branch of some shrub, very full of the minutest berries you can conceive of, and without leaves. But you must not forget to think of the shrub as *hollow* through all its branches and twigs quite into the cells, and as divested of its leaves.

This, however, you are to remember, will not give you a correct idea of the whole lungs, but only of the little tubes and cells for carrying and holding air.

In order to make the shrub, in the case above mentioned, look like real lungs, I must cut the extremities of the twigs, till I bring the bush into the right shape; then I must interweave something like spiders' web or cotton

among all its branches, &c., and thus fill up all the space; and lastly, I must cover the whole with a pale red, but very thin covering.

Thus you see that the trap door at the top of the throat, opens into a large passage which divides and subdivides, almost without end, and leads into as many little rooms or cells as there are of its numerous subdivisions; and that this whole mass, the lungs, fills up one very large room which has no door or opening.

THE VOICE.—Something may properly be said, in passing, about the *voice*.

That part of the throat which is chiefly concerned in the formation of the voice is called the *larynx*, and is at the top of the trachea or large pipe, which goes from the mouth to the lungs, and is very plainly seen, as I have elsewhere said, projecting forward when we throw the head back; though it is rather more prominent in males than in females.

This larynx may be compared to a box, and is made up of five pieces of cartilage. From its upper and hinder corners a ligament goes out, which connects it with the os hy-

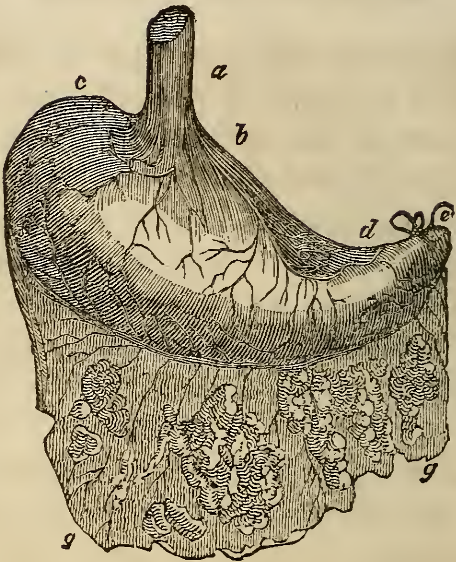
oides—the little bone of the throat before mentioned. In this cartilaginous box are four ligamentous cords, called *vocal ligaments;* and the space which is left between them is the *glottis*—an opening like a triangular slit, widest at the back part, and over which is placed the *epiglottis*, or trap door, which is described in another place. It is the proper and alternate contraction and expansion of the glottis, aided by muscles, upon which depends the tone of the voice. When the chink of the glottis is narrowed, the voice is shrill or acute; and when the chink is widened, it becomes grave or low.

The epiglottis, or covering of the glottis, is hence not only useful to cover the larynx while food and drink are passing along over it to the food pipe, but to assist in breathing, speaking, singing, &c. But the mechanism of the human voice is too curious, as well as too complicated, to be made very intelligible in such a work as this.

The Food Pipe.—The back part of the mouth, where the food pipe or passage to the stomach commences, is funnel-shaped; but

the passage or food pipe itself is tolerably regular in its shape. It proceeds along down near the back bone till it has fairly passed the apartment of the chest, and enters the borders of the great apartment below it, occupying the second or lower story of the building. When it reaches the confines of this apartment, the passage enlarges into a spacious saloon. This is the stomach.

THE STOMACH.—The human stomach has some resemblance, in shape, to the bag of the Scottish instrument of music called the bag-pipe. It lies directly across the body, just under the edge of the ribs, and in such close contact with the diaphragm or floor of the apartment which contains the lungs, that the latter seem to rest directly upon it. The place where the food pipe enters is called the *cardiac orifice*, and the termination or outlet of this spacious saloon is called the *pylorus*, or *pyloric orifice*. The meaning of the word cardiac is not of much consequence; the word pylorus will be explained hereafter.



In this representation of the human stomach, the letter *a* represents the lower part of the gullet, or food pipe; *c*, the left or large extremity; *d*, the end or small extremity, and *e*, the pylorus. The stomach of an adult will hold, when moderately stretched, about two or three pints.

The Intestines.—These commence at the pyloric extremity of the stomach. They wind about in many and various directions, so that though it is scarcely more than a foot

from the place where they begin to the place where they end, their whole length is five or six times the height of the individual. Along with the stomach, they fill up almost the entire cavity or chamber of the abdomen. They are usually described in two divisions—the small and the large intestines.

The small intestines begin at the pylorus, as above mentioned. The first part of them is called the *duodenum*. This turns downward and backward from the pylorus towards the right side. There it makes another turn to the left, where it becomes the *jejunum*. This, after winding about in various directions, terminates in the *ilium*. The duodenum is comparatively short, perhaps not more than a foot or so in length: but the jejunum is longer. The ilium, however, is longer than all the rest of the intestines: in a person six feet high, it is probably more than twenty feet long.

At the lower end of the ilium come the large intestines. These, too, are generally described in three or four divisions or parts. The first of these is called the *colon*.

Just below the place where they unite, the intestine suddenly enlarges, so as to form a

kind of bag or purse, with its hollow part downward. This hollow part, or pouch, is called the *cœcum*. Something in shape not unlike the finger of a glove, projects from it, of the length of three or four inches, but is closed at its lower end, so that nothing can pass through it. This is called the *appendage* of the cœcum.

The colon, continuing its course, first ascends upward on the right side, and crossing the abdomen just under the stomach, and over the duodenum, is called, as it crosses, the *transverse arch* of the colon. Then, turning a little backwards, it goes along down the left side, winding its way, in the shape of the letter S, till, coming near to the extremity of the body, it is called the *rectum*.

Lying in front of, and spread out over the intestines, and hanging, as it were, from the stomach, as may be seen at *g*, in the last engraving, is a fatty membrane, called the *omentum*, or *caul*. This membrane runs in among the smaller intestines, and seems to enclose them, as if they were wrapped up in it. Connected with it also are numerous little glands. They are called the glands of the mesentery.

THE GALL BLADDER.—Not far beyond the stomach is an opening or door, leading through a duct to the gall bladder and liver. The chambers of these two organs are little more spacious than those of the glands already spoken of which secrete the saliva. The gall bladder may be as large as a man's thumb, or sometimes larger. In the same neighborhood is the pancreas, or sweet bread, between which and the main passage through the body there is also a communication.

ABDOMEN.—In this lower story of the house I live in—the *abdomen*—there are several other apartments besides those I have already described, some of which open externally, and others do not. But I must now describe another class of apartments—those which do not have communication with the air.

One of these has already been mentioned: it is the cavity of the chest. Another is the cavity of the cranium, or bones of the head. Another still is in the central part of the brain, or contents of the cranium. The last, but most curious and most important which I shall describe, is the great cavity of the circulation.

Apartment of the Circulation.—This is a larger apartment than many would at first suppose. It must of course be large, to contain, as it does, twelve or fifteen quarts of blood. It is like the hollow channels of two great underground reservoirs or rivers, formed by the union of ten thousand thousand larger or smaller (but most of them very small) streams, running side by side with each other, and in an opposite direction; and which, having no communication with each other in their course, have also no outlet—at least none of any considerable size.

To talk here about the circulation of blood, when my professed object is to describe a chamber, may perhaps seem out of place; but to me, it appears indispensable. For such is the irregularity of this circulatory apartment, that it is next to impossible to describe it, in any other way than by telling you something of its course and contents. But I will be very short.

You may first think of all these streams as if they were filled with blood; and afterward, as if emptied of their blood, and hollow. In the latter case, if a quantity of liquid, such as

water, or melted wax, or even blood, were thrown into the cavities of the heart by means of a syringe, and if considerable effort were made, the liquid thrown in would soon run into all the large and small branches of this multiform channel or apartment, and fill it entirely ; and the amount it would contain, as I have before intimated, would be in an adult equal to three or four gallons—equal in quantity to a common sized pail-full.

Thus you see that though the apartment of the circulation is strangely irregular, it is nevertheless a very spacious apartment—almost if not quite equal to the whole cavity of the chest, in which the lungs and heart are placed ; and not much inferior, in point of size, to the cavity below it—that of the abdomen.

But I must tell you here something more of that part of the circulatory apartment which lies in the heart itself, or in what may be called the little sea or lake into which all these subterranean rivers constantly pour their various crimson floods.

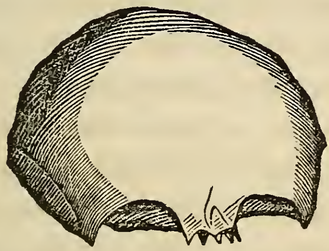
The heart has really four cavities in it, two on the right side and two on the left. The blood which has been sent out into all parts

of the body through the arteries, returns to the first or upper cavity of the right side—the *auricle*—and then passes through into the right *ventricle*. As soon as this ventricle is full, it contracts and presses its contents, the blood, into a great artery, called the pulmonary artery, which carries it to all parts of the lungs, whence it comes back into the left side of the heart—first into the left auricle, and next into the left ventricle. From the latter it is discharged, when the heart contracts, into the great artery, or aorta, and sent all over the body.

These four smaller cavities, or chambers of the heart, taken together, hold, in an adult, about three or four ounces of blood, or nearly a gill. The length of an adult heart, measured on the outside, is about five inches; or we may say, in general terms, that it is about the size of a man's fist.

Something more is to be said, hereafter, about the heart—its cavities, structure, motion, situation, &c.; but I have said all that is necessary in order to give a general idea of the circulatory apartment.

Chambers of the Brain.—Before I describe these I must say something more about the brain itself, though I have partly described it in another place.



Here is a picture of some of the bones of the cranium—those which contain the brain. It is the same plate which you have seen elsewhere; but for the sake of convenience, I have introduced it again in this place.

When I was very young, and heard about the brain, I used to wonder in what part of the head it was situated. I had seen the brain of several domestic animals, such as the ox, the calf, the swine, and the lamb; and as the brains in these appear to occupy only a small part of the head, I concluded that the *human* brain did not. Some person, as ignorant as myself, told me that the human brains lay in the forehead; and with this opinion I grew

up. But since I became a man, I have found out that they extended farther.

The color and general appearance of the human brain are not unlike those of domestic animals; but it is considerably larger in proportion to the size of the body, than that of almost any other known animal.

To give you a more correct idea of its exact size, however, just take a piece of twine and tie it round your head from the bottom of the eye-brows or edge of the forehead to the nape of the neck, letting it come down close behind the root of the ear. Now all above this string, except the skull itself, and the skin, flesh, hair, &c., is brain: and the whole covering, bone, flesh, skin, &c., can hardly be more than half an inch thick, in the thickest part, and in some places scarce a quarter of an inch thick; so that there is, as you perceive, a very considerable quantity of the brain. There is even a *little* brain below the line of the string, but not much, unless that may be called *brain* which runs down into the hollow cavity of the spine, like a large whitish cord, and which I have already told you is the spinal marrow.

The substance of which the brain is made up is usually described by two names—*cerebrum* and *cerebellum*. The former is the upper and front part, which is by far the largest; the latter is the hinder and lower portion, and is comparatively small. Both are united, and are closely covered by three distinct coats or membranes.

The cerebrum is cleft, as it were, on the top, from the fore part to the back part of the head, so as to form it into two large portions, or *hemispheres*, as they are called—the right and left. And yet these two halves or hemispheres lie close together side by side, and are only divided at the cleft by a membrane.

There are clefts or fissures, however, all over the brain; but the one I have just mentioned is in a straight line, whereas the others are winding. Some of them, however, are quite deep—so deep as almost to separate each hemisphere of the brain into several lobes or distinct portions.

The outside membranous covering of the brain is called the *dura mater*. Next is the *tunica arachnoidea*, or spider's-web membrane, which is very thin indeed; and under both

of these is the *pia mater*. The last goes, or as anatomists say, *dips* into all the clefts or hollows of the brain, and also into all its chambers—of which there are many, as we shall yet see.

I have elsewhere told you the weight of the brain. As to its internal appearance, it is so wonderfully and curiously complicated, that it is almost impossible to explain the matter clearly without plates, or even with them.

But as to the general shape of this organ, I may perhaps give you an imperfect idea—an idea somewhat better than none—by saying that the cerebrum or large division of the brain somewhat resembles the half of an egg lying down on its cut or divided part, only that it appears wrinkled, and full of the little clefts or fissures I have mentioned; and the great cleft in the middle seems almost to cut the *half egg* into two parts or *quarters*.

The brain, however, is not exactly of the color of an egg shell, for it is of a grayish color; though much whiter, like marrow, in the inside. It is from this white part that the nerves proceed; which I shall describe presently.

The cerebellum—*little* brain—is only about one fifth as large as the cerebrum, and is below the hind part of it, near the neck.

I have spoken of numerous clefts in the brain. Some of these, on the under side, run in so deep as to form what I shall call chambers—though they are usually called *ventricles*—in the very inside of the brain itself. It is these chambers or ventricles—of which there are four or five—which contain the water, in the disease called *hydrocephalus*, or dropsy in the head; although in the natural state, they scarcely contain anything. Like the stomach and all the organs of the body which are considered as hollow, they are only hollow in that they will hold substances, if required; but when there is nothing in them, their sides fall together and leave no vacancy. There are no real hollows in the human body, with nothing in them but air, (as you may possibly suppose from what I have said here and elsewhere,) except perhaps the ear, and nose, and mouth, and a few small places in the bones.

The philosopher Descartes, thought the soul resided in one of the chambers of the

brain; but the immortal spirit can hardly be said to *reside* anywhere in the body. It is *connected* with all parts, especially the brain, spinal marrow and nerves; and only departs at the period which we call death.

NERVES.—From the under side of the brain, nine or ten pairs of nerves or branches of the white interior part of the brain run off through the skull, which at its base or bottom has many little apertures, and is quite ragged in its appearance, and after dividing and subdividing almost without number, distribute their branches over the various parts to which they are sent.

The first pair—the *olfactory* nerves—go out from the fore part of the bottom of the brain, and are spread over the membrane that lines the nose and its cavities, to enable us to smell.

Next behind them come out the *optic* nerves: this pair goes into the interior of the eye to form the seat of vision—the retina.

The third pair—smaller than the first or the second—are distributed to the muscles of the eyeballs. The fourth pair, which are

very small indeed, also go to the same mus cles.

The fifth pair of nerves is very large, and is divided into three great branches. The branches of the first division are spread, in great numbers, over the forehead, upper eye-lid and nostril; those of the second over the upper jaw, the palate and the adjoining parts; while those of the third are distributed to the muscles and glands of the lower jaw. The uses of this fifth pair of nerves are probably but very imperfectly known.

The sixth pair, like the third and fourth, are distributed to the muscles of the eyeballs.

Next in order as we proceed backwards along the floor of the brain, is the seventh pair, in two grand divisions—the *portio mollis* and the *portio dura.* The first, after entering the internal part of the ear, splits into many branches, and forms the soft pulp found in that part of the ear called the *labyrinth.* The second, or portio dura, is spread over the muscles of the internal ear, the parotid gland, the muscles of the face, &c.

The eighth pair of nerves sends off twigs or branches to the back part of the throat and

the root of the tongue, and then runs downward by the side of a large artery called the *carotid artery*, and is distributed to the heart.

The ninth pair is chiefly spread over the tongue and its muscles.

There is another nerve, called the *great sympathetic*—formed by threads from the fifth, sixth and eighth pairs already mentioned, and perhaps from several others—which, though it does not rise directly from the brain itself, is yet a very important one. It extends along down by the spine, enters the chambers of the chest and the abdomen, and sends branches to all the important organs contained therein. It appears to form a bond of communication between the nerves already mentioned, and those which are to be mentioned presently; and between the parts or organs which they respectively supply. It is by means of this nerve that when one organ of the body is diseased, it disturbs the action of the others, and the contrary; so that when one member suffers, all the members suffer with it, and when one rejoices or acts happily, all the rest rejoice or act happily with it. Hence the doctrine of sympathy in the human system, and

hence the name of this nerve—the great sympathetic.

Next come the spinal nerves. In the sides of the pile of bones called the spine, are holes all along from top to bottom, which are formed by notches in each vertebra. There are also six or seven pairs of holes similar to these, through the sides of the strong bone below, on which the spine stands. Through each of the whole of these holes run large branches of the spinal marrow, which are also called nerves. These are whitish like the marrow itself, and like the brain. Their number is about thirty on each side. They part into branches almost innumerable, and are distributed to nearly all parts of the body.

A puncture with the point of the smallest needle gives us pain, but this could not be unless there were nerves in the part which is wounded. They are so numerous that if there were any way of destroying all parts of the human body except the nerves, without in the slightest degree injuring or displacing the latter, they would present a large mass—whitish, indeed, and not quite so firm—but resembling, in shape, the complete and perfect

living body. The arteries—the vessels which carry blood from the heart to all parts of the body—if all else were destroyed, would probably present the same appearance; and so would the veins.

There is, however, one important difference between the nerves and the blood-vessels. The latter are all hollow tubes, but the nerves are not known to be so. The large ones certainly are not. Some have supposed that the little white pulpy threads or fibres of which they are all made up are hollow, but this is not generally believed.

I have dwelt the longer on the chambers of the brain and the nerves, their furniture, because it is a subject of the utmost importance. But I must now close with a short account of the uses of this wonderful apparatus.

The use of the nerves is to produce feeling, and to convey feeling, or sensation rather, to the brain. I have already told you that nine pairs of nerves go out from the bottom of the brain, and thirty from the spinal marrow which projects from the brain. When the rays of light fall on the retina of the eye—at the

back part of its internal cavity—the optic nerve, which forms the retina, communicates the sensation to the brain in such a manner that we see; when sounds fall into the ear, they affect the brain through the nerves of the ear in such a manner that we hear, and so of all other nerves in every part of the body. That is, if an impression is made upon any part of the body so that we have a sensation of pain or pleasure, it is because a nerve has been touched or compressed, and it has communicated the impression to the brain by means of one or more nerves. The connection is as quick as thought. If you prick a finger or toe, the impression goes to the brain so quick, that we seem to feel the pain at the same instant. We should think it strange if when we dropped a small stone into a stream at its very beginning or fountain, it should agitate the water to the very mouth of the river it helps to form, and even disturb the ocean into which it empties, in the short space of a minute; and yet the impression on the extremity of a nerve runs along it till it unites with other branches, then along the large division till that unites with some other; and

so on till it reaches the brain, with a rapidity much greater than to have the stone affect the stream at its *mouth* in a minute after it was dropped into its *source*.

If by any means a nerve is cut in two, and there is no other nerve that goes to the same part, you may prick, cut or otherwise wound the part as much as you please, without giving much if any pain. This shows that what I have already told you is true. I might add also, that if the nerves which go to an arm or a leg could all be cut off at once, and that too without injuring any of the other parts, the limb would remain nearly or wholly useless.

CHAPTER XV.

FURNITURE OF THE HOUSE, AND ITS USES.

The blood. Preparing the blood. Mastication, or chewing. A trap door. Digestion. Formation of chyle. Lacteals. Absorbents. Materials for blood. Nature of the blood. Nature of secretion. Motion of the heart. Pulsation. Force of the heart. Capillaries.

We come now to the furniture of the house I live in, and its various uses. This will make a long, but I trust an interesting chapter.

Here, however, our similitude begins to fail; for while the house I occupy, like all other houses, is liable to daily waste and decay, there are, in the human habitation, certain pieces of furniture—perhaps I should say machinery—by means of which, if properly managed, repairs are going on equal, at least, to the waste. But in no ordinary dwelling can any such process be found. All dwellings may indeed be repaired, but it is usually

by external aid, and not by any operation of their own from within.

The habitation of the human soul is kept in repair partly by means of the rivers which run through the circulatory apartment. It was this fact that made it necessary for me to dwell so long upon this apartment in the previous chapter.

The Blood.—There is nothing in this part of the universe which so much resembles the economy of the human body, and the means by which its constant waste is supplied, and the whole kept in repair, as the manner of watering and supplying the face of the earth. Evaporation, and the growth of plants and animals, are constantly wasting or drying up the soil; but there are numerous hidden streams, some of them very small, that wind their way in almost every direction, and continually furnish new moisture.

It is true, there are also large streams, which appear on the surface of the earth, very different from what is found on the outside of the human body; neither is it to be forgotten that the earth is watered, in part, directly

from the atmosphere. Still there is a striking resemblance between the two great processes. The one is to supply constantly the wants of a world; the other, to supply the demands and repair the waste, &c., of what, for the sake of its near relation to its celestial habitant, is worth far more than any known globe.

PREPARING THE BLOOD.—But how is this blood, in its ten thousand thousand crimson streams, prepared and supplied to the human body?—for it must first be *made* before it can be supplied. It is a most curious, and indeed wonderful process, and one which demands a particular description.

MASTICATION, OR CHEWING.—I have already told you about the teeth, their number, their uses, &c. I am now ready to say that they are principally designed for breaking up and grinding the food—the material of which the blood is to be made. For the great Author of our frames has so ordered it, that as fast as our systems waste, a feeling arises in us which we call hunger; and we take much pleasure in gratifying that hunger. But

in order to gratify it properly, and to recruit the waste of the body, there is a work for the teeth to perform, of which I have just spoken.

But while the teeth are breaking in pieces our food, the salivary glands, described in another place, are continually secreting and pouring through small tubes into the mouth a quantity of saliva just sufficient to moisten it, and render it somewhat of a pulpy consistence. There are also other little glands, under the tongue, which assist in the work.

When the food is beaten fine and moistened sufficiently, it is gathered together upon the tongue, and by a series of curious movements, which I have not room in a work like this to explain, it is pushed along beyond the root of the tongue to the top of the gullet, or food pipe, whence, by muscular action, it is conveyed downward into the stomach.

In its passage towards this organ, it goes directly over the trap door of which I have already spoken; and were not this little flap most ingeniously contrived for the purpose of preventing it, at least in part, it would sometimes drop into it. If we laugh, or cough, or speak, or sing, while the food is passing by

this opening, there is very great danger of its falling into it.

TRAP DOOR.—It is true that this door usually closes when anything approaches, almost as quickly as I formerly told you the eye does, when anything approaches that organ. But it is also true that, as in the case of the eye, it does not always close quite soon enough; and substances sometimes actually fall into the trachea. When they do, they produce irritation and tickling, and induce us to cough, which occasionally throws up the offending substance. When it does not, the coughing frequently soon subsides; and if the substance is nothing harder than a piece of bread, it dissolves gradually, and is slowly coughed up; but if it is something harder, as a piece of a chestnut or a kernel of corn, it usually causes trouble; which, unless the surgeon can remove it by cutting open the windpipe, ends in death.

While writing this chapter, I have read in the Boston Medical and Surgical Journal, of a little girl, five years old, who, in playing with a brass nail, was so unfortunate as to have it fall into her windpipe. It produced a

little coughing, and then all was quiet; and the parents and friends thought all danger was over. But more than a year afterward, on taking a cold, a bad cough, with hectic fever, night sweats, and bleeding at the mouth, came on, and she died of a rapid consumption. On opening her body, the brass nail was found imbedded in her lungs.

I hope every young person who reads this account, will avoid holding nails, pins, buttons, &c., in the mouth, as well as all talking and laughing while eating; for it is at least dangerous, and may prove fatal.

When the food is fairly beyond the tongue and the little trap door, it goes into the top of the food pipe, as into a sort of funnel top. Below, this pipe is smaller; but, if we eat and swallow slowly, not so small as to hinder the food from passing. Still, if we do not half masticate our food, or if we swallow it too rapidly, it is sometimes retained in this passage, and causes great trouble. I have known persons come very near dying, by having a large piece of meat, or some hard or unchewed substance, get lodged here; and it was only by the help of the surgeon, that their lives were saved.

Digestion.—The food, however, at length arrives in the stomach. Here, after remaining a short time, it gradually softens still more than before, and becomes a grayish or whitish pulp, called *chyme*. The formation of this chyme is greatly hastened by a fluid called the *gastric juice*. This does not travel a long way through pipes, like the saliva, but seems to ooze as it were out of the inside of the stomach, in large drops, as you have seen the drops of water or sweat from the forehead of a laboring man, in a hot day. This process is called a *secretion*.

When the outside of the mass of food which is in the stomach becomes soft, it is slowly conveyed, by a curious motion of this organ, from its left towards its right end, to what I have already told you is called the *pylorus*, by which term is meant the door or outer gate of the stomach—or, as some call it, the door-keeper. It may well be called a door-keeper, for it really seems to exercise a sort of choice; for if anything presents itself which is not proper for the system, or rather, is not fitted to make blood, it does not for some time suffer it to pass; though after the substance has

repeated its efforts to pass a great many times, it appears to yield, as if to importunity. True chyme, made of good and proper materials, it never refuses, but suffers it to go on at once into that portion of the intestines next beyond the stomach, called the *duodenum.*

The outside of the mass of food having been subjected to the process I have been describing, that portion directly under it is submitted to the same treatment, and so on, till the middle portion is brought into contact with the gastric juice, and the whole mass converted into chyme, unless there is too much of it, or the person is weak or feeble, or the food is improper in its quality.

FORMATION OF CHYME.—The food in the duodenum becomes a still more perfect chyme, and is gradually mixed with a bitter liquor, called *bile,* coming through a small pipe from the liver, and also with a liquor resembling saliva, coming from the *pancreas,* or, as it is called, sweet bread.

The *liver,* which I have barely mentioned in another chapter, is a large organ—a gland —which fills up a considerable portion of the

abdomen, principally on its upper and right side. The *pancreas* is another gland, not so large, lying a little way from it, but nearer the spine.

The food, being mixed with these liquors, slowly passes along, and spreads itself over nearly the whole internal surface of the intestines. It is always in greatest abundance, however, in the duodenum, and a few feet of the intestines next to it.

Lacteals.—There is in the human body a set of little vessels called *lacteals*, which begin in great numbers, as if by roots, in the sides of the intestines, and gradually uniting as they proceed, they all at length come together into one principal trunk or main pipe, which, with its branches, might be compared to the trunk or stem of a tree. These vessels —or their roots—seem to begin on the inside of the duodenum and other intestines, with open or funnel-shaped mouths, with which they suck up the finer or better parts of the chyme within them, and which, during the operation of being taken up, is changed into a pearly colored or milky fluid, called *chyle.*

This process is commonly called absorption; and the vessels by which it is performed, *lacteals;* though they are sometimes called by the general term *absorbents.*

The chyle, after being taken up, is conveyed along in the small vessels it begins with, till they unite with others, like small streams with larger ones. These again unite with those which are still larger, until they at last meet in a grand trunk or receptacle, near the fifth vertebra of the loins. This main duct is called the *thoracic duct.* Important as this part is, in the human machinery, it is not larger than a common quill.

From this receptacle or reservoir, one or more pipes or ducts go out to carry the chyle which it contains up towards the top of the left shoulder. Here is a great vein, which brings back the blood from the left arm, and pours it into the heart; and into this vein the chyle is poured, and mixed with the blood, with which it immediately descends into the heart, and passes directly to the lungs, to undergo a very important process, to be described by and bye.

Absorbents.—There is another set of vessels, found in almost all parts of the human body, which unite, by their tributary streams, to form this mass of liquid which is thus poured into the veins. They are in greatest numbers at the inner parts of the thighs and arms, at the neck, and in the groins; though they are very numerous, as I have already said, in almost all the soft parts of the body—the brain perhaps excepted. They are so small as to be seldom seen, except with a microscope.

These vessels are called *absorbents*. They absorb or suck up any particles not wanted in one place, and carry them back into the blood, to be sent round again, to be used where they are really wanted, or else to be expelled from the body. The liquid which is found in these vessels is called *lymph*. It is of a pale red color, but wholly different from blood. Besides having the general name of absorbents, these vessels are sometimes called *lymphatics*.

I have said that the chyle is pearl colored; but that depends, in some degree, on the kind of material from which it is prepared. If that consists partly or wholly of flesh, the chyle is

more or less milky in its appearance; but if the food is wholly vegetable, the chyle is of a fine pearl color.

The chyle, in its pure state, is similar to the blood, except in color. The little globules, (small round bodies,) which swim in the blood, and give color to it, are numerous in the chyle; but instead of being red, as in the blood, they are white. I have said that the chyle, in its nature, is like the blood; but of the nature of the latter I shall have occasion to say more, presently.

Whether the chyle is changed to a red color as soon as it is mixed with the blood, or whether the change does not take place till it has passed with it through the lungs, we can better judge, perhaps, when we come to speak of the blood, and the changes it undergoes in those organs.

Having thus traced the food, or raw material, through the whole of a most wonderful manufacturing process—that of *digestion*—till chyle, and perhaps blood is formed from it, it may be well to pause and consider, for a few moments, the different materials from which this most important fluid is prepared.

Materials for Blood.—The great Creator has so formed this wonderful apparatus, that it has the power of forming chyle from almost all substances, either in the animal or vegetable kingdom. Some make more, others less; some make it of excellent quality, others of a quality very inferior. From some it is formed very rapidly; from others, very slowly. Some things, in the process of digestion, give out a great deal of heat; others, very little. Lastly, some substances produce great excitement and disturbance of the stomach and other organs, while others produce hardly any disturbance at all.

As a general rule, those things which produce the least disturbance of the digestive organs, and of the other organs of the body, as well as the least heat, make the best chyle and the best blood; and are, of course, the best adapted to our use. It must be observed, however, that much depends upon habit; and that a substance which is naturally rather inferior to another may, by habit, be rendered for a time somewhat more useful.

Among the best things to submit to the process of digestion are, bread made of wheat

flour unbolted, from one to three or four days old; bread made of corn meal and rye meal, either separate or mixed; plain puddings made of rice, sago, tapioca, &c.; potatoes and other garden vegetables, apples, pears, peas, beans, &c. For infants who have no teeth, milk, as is well known, forms the best chyle and blood. For adults, a tolerable sort of chyle may be formed of plain, lean meats, fish, milk and eggs; and an inferior sort of butter, cheese, cakes, pies, hot bread, beets, turnips, onions, &c.

All these substances may be better or worse, according as they are more or less broken and ground down with the teeth, and mixed with the saliva; and also according to their quantity. The best of them, if not well masticated, make but an inferior sort of blood; and the worse, if well masticated, make chyle and blood which answer, in some good degree, the purposes of health. So of quantity: those which are even excellent in their nature, are not so good, if taken in excessive quantity.

Spirit makes no chyle or blood at all; wine, cider, ale, beer, coffee and tea, very little, unless milk, sugar, molasses, or something of

the kind is mixed with them. Besides this, they contain, more or less, qualities which not only do no good, but are positively hurtful. Even water can hardly be said to make either chyle or blood; but then it quenches our thirst, and answers many important and even indispensable purposes.

I am now to tell you about the blood;—first, what it is; secondly, its uses; thirdly, how it is kept in a good and healthy condition.

NATURE OF THE BLOOD.—If we open a vein with a lancet—as you know physicians and surgeons sometimes do—and draw out a quantity of blood into a bowl, or any other vessel, and let it stand in the open air, it soon begins to clot or thicken, or, as it is usually called, *coagulate*.

From the surface of this coagulated part a yellowish watery fluid oozes out, in numerous small drops, which gradually increase and unite, till, in a short time, there is more of this thin liquid than there is of the thicker coagulated part. This watery part is called the *serum*.

If we take the coagulated part of the blood, and wash it thoroughly, though carefully, we

may divest it of nearly all its coloring matter, and leave it white. This white substance is called *fibrine*, and strongly resembles the fibrous or thread-like substance of which I have already told you the muscles are formed.

The coloring matter, which we wash out, consists of small, round or *globular* particles, which, before the blood coagulates, float in it; but, during the process of coagulation, become entangled in the fibrine. You have also been informed, in another place, that these globules exist and float in the same way in the chyle, before it mixes with the blood. In the chyle, however, they are colorless.

What gives the color to these globules in the blood is unknown. Some suppose it is the iron, or rather phosphate of iron. Phosphate of iron, it is well known, exists in the blood, in small quantity. Dr. Good thinks there is about three ounces in an adult; and that there is, of course, about enough in forty men, to make a ploughshare. Sulphur is also found by chemists in the blood; but they do not tell us in what proportion.

Thus we see that the three principal ingredients of the blood are the coloring matter, the

fibrine, and the serum. The serum is principally albumen and water; though it also contains, in small proportion, besides sulphur and iron, a great variety of substances, especially alkaline salts. Albumen is a substance which you may consider as resembling the white of an egg; for the latter is almost wholly composed of it.

Uses of the Blood.—All parts of the human body, whether solid or fluid, and whatever may be their appearance or structure, are formed from the blood. I have told you how this fluid is sent out by the heart to all parts of the system, even to the bones. I have also said a few words about the saliva, and the gastric juice, and the bile; and have called them secretions.

It may be necessary to observe, in this place, that by the word *secretion*, as used in this book, is meant something formed from the blood. Not only the saliva, the tears, the gastric juice, the pancreatic fluid and the bile, are secretions, but the mucus which is everywhere found in the mucous membranes of the body, the water in the brain, the lungs, &c.

In short, wherever you find water or anything else, inside of the body, except in the intestines or the bladder, you may be pretty sure it is formed from the blood. Most of the fluids thus formed in the body are termed secretions.

You will perhaps ask how secretion is effected. Sometimes it is by means of glands, larger or smaller; sometimes without them. A gland is a soft body, full of vessels—veins, arteries and absorbents. These vessels seem so numerous that one might be led to think the gland was wholly made up of them. Here is a picture of the vessels of the kidneys, as

they would appear if a slice of this organ were carefully viewed, after the blood had been wiped away.

The kidney, however, is not so good a specimen of the nature of a gland as the liver would be. The larger glands of the human body are the liver, the spleen, the pancreas, the salivary glands, the lachrymal glands, &c. Besides these, there are smaller glands almost innumerable. The cerumen or wax of the ear, and the oil of the skin, of which I have already spoken, are secreted by little glands.

The lymphatic or absorbent vessels are everywhere connected, in their passage through the body, with little glands. Some of these are larger, some smaller; and most of them are very small indeed. Those little swellings called *kernels*, which sometimes appear in the armpit or groin, or in the sides of the neck, are nothing but inflamed lymphatic glands.

All these glands, (except the lymphatic glands, whose use is unknown,) secrete something; and the material for secreting anything from, is the blood sent to them from the heart, into their ten thousand little vessels.

Nature of Secretion.—I have already observed that some of the liquids, &c. of the human body seem to be secreted without the help of glands. They appear to be made directly from the blood-vessels. How, we do not know. It has sometimes been thought that they ooze through the sides of the vessels.

Here, perhaps, in one vessel, is blood; there, outside of it, but hardly a hair's breadth from it, is gastric juice, or some other entirely new substance. Here is simple chyme or chyle; there, at the distance of a hair's breadth, is chyle or blood. Here is chyme or chyle made of common food, with no sulphur, or iron, or nitrogen in it; there, perhaps not the twelfth part of an inch distant, is a fluid made from this very liquid, containing sulphur, nitrogen and iron!

By what secret laws of the Creator have these little vessels this wonderful power? By what mysterious process can they change—almost in the twinkling of an eye—a bland, milky substance, made from simple bread, or milk, or potatoes, into iron or sulphur? But so it is. Well, indeed, might David the Psalmist express wonder.

Not only the liquid parts, but the solid parts too, are made from the blood. The very bones themselves, at first gelatine, are gradually made into bone, by means of the blood in its little vessels. First, a particle of gelatine is taken away, by the absorbents; then comes along a particle of blood, or something that the blood contains, and stops in its place; and so on.

These particles, which are thus taken out to form bone in the place of gelatine, are many of them lime, or phosphate of lime, or at least something which makes lime, before it can become bone. Who directs the little particles of lime to the places where they are wanted? Who tells them to stop at the bones, and not before?

The power of the system to take out from the blood what is wanted for its growth and support, is aptly shown by Dr. Edwards.* He had been speaking of the wonderful distribution of the blood, in the little arteries, to every part of the body, when he thus added:

* See the Eighth Report of the American Temperance Society, page 11.

"Along on the lines of these little tubes or canals, (the arteries,) through which the blood, with all its treasures, flows, God has provided a vast multitude of little organs or waiters, whose office is, each one to take out of the blood, as it comes along, that kind and quantity of nourishment which it needs for its own support, and also for the support of that part of the body which is committed to its care. And although exceedingly minute and delicate, they are endowed by their Creator with the wonderful power of doing this, and also of abstaining from, or of expelling and throwing back into the common mass, what is unsuitable, or what they do not want, to be carried to some other place, where it may be needed; or if it is not needed anywhere, and is good for nothing, to be thrown out of the body as a nuisance.

"For instance, the organs placed at the ends of the fingers, when the blood comes there, take out of it what they need for their support, and also what is needed to make finger nails; while they will cautiously abstain from and repel that which will only make hair, and let it go on to the head. And the

organs on the head carefully take out that which they need for their support, and also that which will make hair, or, in common language, cause it to grow; while they will cautiously abstain from taking that which is good for nothing except to make eyeballs, and let it go to the eyes; and will even help it on. And the organs about the eyes will take that, and work it up into eyes, or cause them to grow. And so throughout the whole."

By this we may plainly see that there must be a constant waste in every part of the system. It is impossible but that the friction—the "wear and tear" of hundreds of muscles and tendons, and thousands of rapid streams—should gradually produce an effect, let the parts be ever so hard. A continual dropping will wear away a rock.

Now the blood not only carries out little atoms or particles to make all parts of the body grow, and to replace the atoms that are worn off by friction in our motions, but it also takes away the worn out and good for nothing particles, and carries them out of the body. It is true they are taken up by the absorbents

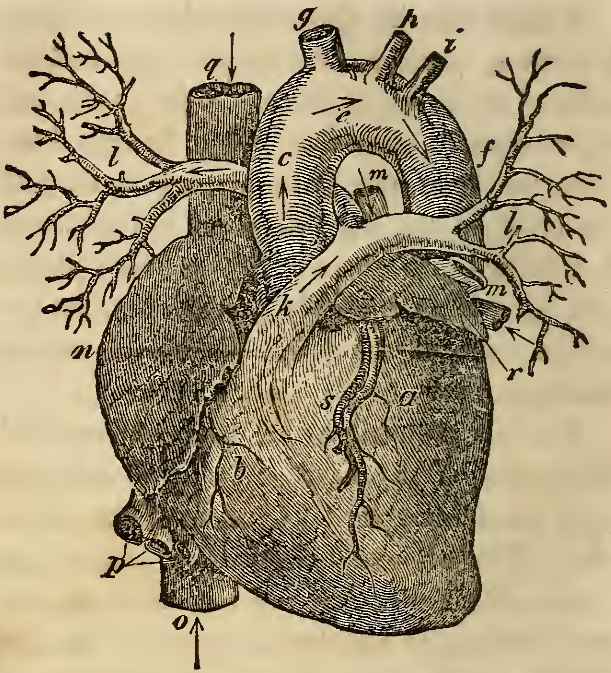
in the first place; but then the absorbents carry them to the blood, and empty them into it, which amounts to the same thing. In this way, as you may easily see, the blood is liable to lose its purity and excellence, since it is constantly giving out good particles, and receiving bad ones.*

MOTION OF THE HEART.—The heart is kept in motion—we know not how; nor can the wisest anatomist or physiologist in the world tell us. We know that the lungs have something to do in the case; and when once set a-going, we can form some idea of what keeps it in motion; but after all, the real causes of the continued motion of either the heart or the lungs is a great mystery; and may possibly always remain so.

* The manner in which the bad or waste particles are removed from the system is very curious. The kidneys seem to be a sort of sieve or filter; with this difference, however, that while a sieve permits only the finest and best parts to pass through it, the kidneys filter out the worse or coarser parts. These are carried in two pipes called *ureters*, to the bladder, whence they are conveyed immediately out of the system.

I might mention also in this place, that there is a strong partition between the right and left sides of the heart, so that the right auricle and right ventricle, with their blood brought back from the veins, can have nothing to do with the blood in the left auricle and left ventricle. It is indeed as if there were two hearts placed side by side, and closely pressed together;—and in some of the lower animals, I believe there are really two.

You are probably aware that you can feel the motion of the heart, if you will only lay your hand on your left side, near the lower ribs. This important organ—not larger than a man's fist, and strong and muscular—is situated slanting, or obliquely, as you see in the following engraving. It is represented nearly in the position in which my heart would appear, if you could stand before me this moment, and see it just as it now is, in full motion. I mean, its position is just what it would then be. In other respects, it would appear differently, especially in its connections; for the vessels which go to it and come from it are here represented as cut off.



In this engraving, *o* and *q* show the stumps of the two great veins, which bring back the blood that has been distributed to all parts of the body by means of the arteries. They are called the *venæ cavæ*. There are, however, one or two other large veins which bring back blood. These you see at *p*. The right auricle is at *n*; *b* is the right ventricle; *k* represents the pulmonary artery, through which the blood is sent to be changed in the lungs—of

which *l l* are the right and left branches; *m m* show the great veins—pulmonary veins—that bring back the blood from the lungs into the left auricle; *a*, the left ventricle; *c e f*, the great aorta, through which blood is sent out to all parts of the body; and *g h i*, the branches of this artery which carry blood to the head, neck and arms. The little arrows point always in the direction in which the blood runs. The letter *s* points out the coronary arteries, which carry blood to the heart itself.

But I must explain to you, more fully, the motion of the heart. The blood which returns from the lungs, through *m m*, and that which returns from all the rest of the body, through *o p q*, enters both the right and left auricles at the same instant, and also in the same instant flows through these auricles into the two ventricles.

Thus both sides of the heart fill in the same instant. Now let us suppose them filled. What is next to be done? The heart contracts—shrinks—and compresses the blood with as much force as a strong man could compress it with his hand. But suppose you held in your hand a fleshy sack of blood that

contained two or three ounces, with little hollow branches, that parted into ten thousand more into which the blood could flow, but could not get out at their sides or extremities. Suppose them now all full, and the sack full, too. If you press the sack hard with your hand, what will happen? Why, the blood, you will tell me, will go out of it into the branches. It will; but it will be as likely to go into one as another, provided it is equally large.

But there is another difficulty. As soon as I cease to press the sack, and the blood has an opportunity to do so, it will run back into it again. So you may, perhaps, at first view, suppose the heart would do. As soon as it should cease to contract, and begin to relax, so that its cavities or chambers would hold just as much as they did before, the blood would run back into it. Why should it not? No motion like that in our bodies would ever, in this way, be produced.

I have told you what one might naturally think, who knew nothing about the circulation. But let us see for a moment what the facts are.

When the two auricles, one on each side of the heart, are full of blood, they contract at the same time, and press the blood into the two ventricles. If you ask why this blood is not just as likely to go back into the veins again, when the auricles contract, as to go into the ventricles, I will give you two reasons. First, the veins are already full, and the mass of blood in them is flowing onward and pressing towards the auricles; and to force the blood back into them would be somewhat like pushing it up hill. But secondly, there are little clappers, or valves, as they are called, in the sides of the veins, which, like so many small swinging doors, hang down against the sides of the veins, so long as the blood in them is running towards the auricles. But as soon as the auricles contract, and the blood attempts to get back by the way it came, the valves spread out and form a kind of floor or partition, which obstructs it.

Now the ventricles both contract; and as was the case with the two auricles, they both contract in the same instant. This contraction pushes their blood into the arteries, as I have before told you. The right ventricle pushes

its blood into the pulmonary artery, whence it goes into the lungs; and the left ventricle pushes its blood into the great aorta, through which it goes to every part of the body.

Why does not the blood, when the ventricle contracts, go back into the auricle? Because there are valves between them, which immediately spread out, like so many flaps or clappers, and form a sort of partition or floor, as the valves do in the veins, and prevent it. They do not, it is true, prevent every drop of it from returning. A very small quantity gets back, but none worth mentioning.

We have seen how the blood gets out of the auricles into the ventricles, and why it goes into the ventricles, rather than back into the veins. I will now say a little more about the structure of the veins.

The valves, of which I have spoken, are found in the larger veins all over the body; and now comes the reason why the blood can run up hill. The pressure in the veins is all the while diminishing, as you may easily see, on the side towards the heart, even though it is the up hill side; and as the arteries, at their extremities, are all the while pouring their

blood into them, the pressure must be as constantly and certainly increasing on the other side. Besides this *general* pressure, there is also *local* pressure. The veins lie, most of them, in the skin, or among the muscles, or among parts that are performing some sort of motion. This motion must push the blood in one direction or another. But as the valves prevent its going back, the pressure is hard enough to make it go slowly up hill ; and thus it moves onward and onward, till it finds its way to the heart.

It is the contraction of the ventricles, which I have described, that causes the motion of the heart, and which is felt so plainly on the outside of our bodies. It takes place in an adult male, in good health, about once a second ; in females, it is rather more frequent. It is most frequent, both in males and females, at birth ; and diminishes in frequency till we come to middle age.

Pulsation.—This beating of the heart, as the blood is pushed from it into the arteries, seems to be felt in the large arteries all over the body. I say *seems* to be ; but the subject

is not well understood. We only know that if we lay our finger on an artery at the wrist, or in the ankle, or any other extreme part of the body—feel the pulse, as it is called—this beating in the extremities corresponds exactly with the beating of the heart.

Physicians can tell something about disease in a person, by the state of his pulse. This may be hard, soft, swift, slow, strong, weak, regular, irregular, &c. They feel at the wrist, because there is an artery at the wrist which comes very near to the surface, whereas most of the arteries lie very deep in the body or limbs. A few others, however, may be felt; and the Chinese physicians feel the pulse in many parts of the body, thinking—as they do not understand anatomy and physiology—that it may be swifter in one place, and slower in another.

Force of the Heart.—The force with which the ventricles press the blood to push it out of the heart has been variously estimated. Some reckon it at only a few ounces; others, much more; and some, 180,000 pounds. The truth is, that it presses very hard—with a

force apparently equal, if not superior to that of the gripe of a strong man with his fist. But it does not press with a force equal to thousands of pounds, nor even hundreds. I suspect it may average, in an adult, from 20 to 30 pounds.

One reason why anatomists have made such strange calculations is, that they could not conceive how the blood could otherwise be carried so swiftly to all parts of the system. The distance it has to go, in some instances, is great, for the arteries are very crooked. But they seemed to forget that, by the curious structure we have mentioned, the veins were all the while getting empty, and a sort of vacuum* forming in their cavities, into which the blood would naturally rush from the arteries, so that the pressure, or rather the resistance of the latter to the contents of the heart would be constantly diminishing, and thus there would be a tendency to a regular current of the blood.

* It is said—and with some truth—that nature abhors a vacuum.

Capillaries.—They appear also to forget the structure and nature of the little arteries—sometimes called *capillaries*—found in such numbers in the skin, the muscles, and indeed everywhere in the body. The truth is, that the coats of these little vessels are muscular; and it is a pretty well established fact, that they have the power of drawing the blood from the heart. Dr. Smith, late an eminent professor of surgery in Yale College, thought that these capillary vessels did almost all the work—the heart doing very little.

Others too have thought the same. They have considered them as little pumps, all over the body, that were continually pumping up the blood from the deep well of the heart to the extremities of the remotest chambers of the system. You may form some idea of their meaning, by thinking of the Astor House in New York, and other public houses built on the same plan, where water is carried by means of pumps and other machinery to every room in the house—even to the highest story and the remotest chambers.

The truth here—as almost always happens—falls between the extremes. The heart re-

ally pushes the blood with considerable force; and the muscular capillaries, at the same time, act in a slight degree like little pumps. Then the vacuum I have spoken of has some influence; and there may be other causes in operation, which I have not mentioned. The whole process of circulation is wonderful, and it requires a large volume to illustrate and explain it fully.

Review of the Circulation.—I will here insert a very good account of the circulation, abridged from one of the English magazines. Some things will be found in it which have been already mentioned; but I think it will still be very interesting and highly useful.

"The heart is placed within the breast, between the two lobes of the lungs. It is a fleshy substance, and has two cavities, which are separated from each other by a valve. From the left ventricle, a large blood-vessel called the *aorta* proceeds, and soon divides into several branches, which, ascending and descending by innumerable divisions, become smaller as they proceed, and penetrate every part of the body.

When the right ventricle contracts, the blood is propelled into the arteries with so much force that it reaches the smallest ends of their most remote branches. This motion is called the *pulse*, which is merely the effect of the pulsation of the heart, and is quicker or slower according to the frequency of its contractions.

When the blood reaches the extremities of the arteries, Nature employs or uses it in the wisest manner. Certain vessels, of a particular description, absorb its watery, oily and saline (saltish) parts, to make new substances, as milk, fat, bile, &c. What is not used, flows into the extremities of the vessels called *veins*. These vessels gradually enlarge in size, till they form very large tubes, which convey the blood back to the right ventricle of the heart. It is then propelled into the pulmonary artery, which disperses it through the lungs, by means of innumerable small branches. It is there exposed to the action of the air, and carried through the pulmonary veins to the left auricle of the heart. This contracts, and sends it to the left ventricle, which also contracting,

pushes it into the aorta, whence it circulates through every part of the body.

For this complicated function, four cavities, as we have seen, become necessary, which are accordingly provided. Two of these, called ventricles, send out the blood, (one into the lungs, in the first instance, the other into the mass, after it has returned from the lungs.) Two others, called auricles, receive the blood from the veins—one, as it comes immediately from the body, the other, as the same blood returns a second time, after its circulation through the lungs; for without the lungs, one of each would have been sufficient.

Such is the admirable circulation of the blood, in man and most animals.—Yet shall this wonderful machine go night and day, for eighty years together, at the rate of one hundred thousand strokes every twenty-four hours, having at each stroke a great resistance to overcome, and shall continue this action, for this length of time, without disorder and without weariness."

CHAPTER XVI.

FURNITURE, AND ITS USES—Continued.

Purifying the blood. The lungs. Capacity of the lungs. Breathing. Uses of breathing. Nature of the air. Breathing air twice. Ventilation. Free motion of the lungs. Tight lacing.

We are now prepared to enter upon another subject—the study of the process by which the purity of the blood is promoted, in spite of the many causes which are continually in operation to render it impure, and unfit for its purpose.

Purifying the Blood.—This is done by means of atmospheric air. But how is air to be introduced into the human body? Can we eat it? Can we drink it? Can it enter by means of the eyes, or the ears, or the nose? Not exactly in either of these ways. It can indeed enter into the nose; but without some other machinery, it would go no farther

than the throat, before it must return or pass out at the mouth. A little, it is true, is swallowed, both with our food and drink; but the quantity is not very considerable.

There is air, moreover, in almost every part of the body: if there were not, we should soon be crushed. The atmosphere in which we live presses on us with a tremendous force, equal, it is said, in a middling sized man, to about 32,000 pounds to the whole body, or 15 pounds to every square inch. But as there is air within us, in all our solids and fluids, which presses outward, while the atmosphere presses in the other direction, we do not perceive its weight.

When I said the blood must be purified by the air, I meant in a manner much more rapid and effectual than could be done by its gradual introduction, and its circulation through the vessels. The manner of this change I will now endeavor to describe.

THE LUNGS.—The house I live in contains something like a great bellows, by whose curious operation the blood is cleansed and purified. This is contained in the upper story,

and fills nearly the whole of it, leaving only a small chamber at one side for the heart. It blows its blasts at the rate of twenty or twenty-five a minute in an adult—and at a greater rate still in children;—and it continues these blasts, whether we stand or sit, sleep or wake, as long as we live. I refer, as you will readily know, to the lungs.

I have already spoken briefly of the lungs. I have told you about the windpipe, which leads by its various branches to the ten thousand little cells within; and I have told you that all these cells were lined with mucous membrane—a membrane constructed like the skin, though thinner. But I believe I have not yet told you how much air these chambers of the human body will hold, nor how great are the superficial contents of the membrane on which the blood is spread to be purified.

So numerous are the pipes and cells in the lungs, that it is commonly thought the extent of the mucous membrane which lines them must be equal, at least, to the extent of the skin, which, in a middling sized adult, is about fifteen square feet. Over all this surface the fresh air which we breathe may circulate, so

long as we are in health, to fulfil its office in effecting that change in the blood of which I am about to speak.

Capacity of the Lungs.—As to the quantity of air which the lungs will hold, it is very differently estimated. Many anatomists think it about 200 cubic inches, or three quarts, in the adult male; but I think there must be a mistake in their calculations, and that it cannot exceed two quarts.

When we breathe out, or *expire*, as it is called, we do not expel all the air actually in our lungs, but only a small part of it. Of course, when we *inspire*, we merely introduce air enough to supply the place of what was before expelled. The process of inhaling air is called *inspiration*, and that of expelling it, *expiration*. Both these taken together, that is, the whole process of breathing, is called *respiration*. The amount of air which we draw in or inspire at each breath, (I speak of an adult still,) is thought to be about forty cubic inches, or something more than a pint; but this estimate has also been thought too high. Females, with lungs somewhat smaller

than males, inspire a quantity still less; and children, a quantity smaller still.

Breathing.—But how is the process of breathing performed? To understand this, it is necessary to revert once more to the structure of the frame-work of the human system.

The ribs, though fastened to the spine, or back bone, are not so firmly fixed but that they admit of considerable motion. This motion is very curious, though somewhat difficult to describe. I can only say that it is of such a nature, if unconfined and unrestrained, as to enlarge the cavity of the chest when we inspire, or draw in our breath, and to diminish it when we expire, or breathe it out.

This motion of the ribs is caused, in part, by the shortening or contracting of the muscles about the chest. Of these, there are two between every two ribs; and as there are, on each side, twelve ribs, making twenty-four in the whole, there are forty-four of these muscles concerned in moving the "bellows," every time I breathe. In addition to these, there are nearly one hundred others more or less concerned in this operation.

In a healthy adult, from twenty to twenty-five of these inspirations are performed in a minute, as I have already told you. When we exercise violently, as in running, leaping, swimming, &c., the motion is more rapid. So also it is in childhood; and sometimes in fever and other diseases. When the lungs move faster, the heart beats faster, too, in the same proportion—the breathing and the contractions of the heart usually bearing an exact proportion to each other.

Now what is the object of all this motion? For what purpose is a pint of air drawn into the lungs, and spread over fifteen square feet of internal surface, every three seconds, and another pint withdrawn from them as often? This I can, in part, explain to you.

Uses of Breathing.—In its healthy, natural state, before it is sent out into all parts of the body, the blood is composed of carbon, oxygen, nitrogen and hydrogen. Of one hundred parts of blood, fifty-three are carbon, twenty-four oxygen, sixteen nitrogen, and seven hydrogen.

But when it has been circulated all over the body, and has returned through the veins to the right auricle and ventricle of the heart, its properties become greatly changed. It is now of a deep purple hue, and has hence been often called black blood.

In this state, it is found to be loaded with too great a proportion of carbon; and this, too, notwithstanding what has been done by the skin; for it is a most striking fact, that this very work of purifying the blood, of which I am about to speak as taking place in the lungs, takes place in a small degree all over the surface of the body. Still it does not complete the work, and the blood continues to come from the heart through the pulmonary artery to the lungs, in its impure, purple or black state; not only overloaded with carbon, but mixed with such other noxious ingredients as render it unfit for the use of the organs where it travels, in forming their various parts, secretions, &c. It also brings back with it—at least a few hours after every meal—a mass of chyle, which probably needs a change to be effected in the lungs, before it can become

blood, and be prepared to afford nourishment to the system.

Having arrived in the lungs, it is spread, almost immediately, over the vast space which is afforded by their numerous cells, and thus exposed to the influence of the atmospheric air. This produces a most surprising change; and the blood is now sent back into the left auricle and ventricle of the heart, to be distributed all over the system, in a purified or renovated state. Its color is changed to a bright scarlet; it has lost its superabundance of carbon, and its other bad qualities, and has acquired new life and vigor.

Of the precise nature of this change, whether the blood takes in something from the air, or whether the air takes something away from the blood, there has hitherto been a great difference of opinion; and even now, the point is not wholly settled. It is sufficient for us, in a book like this, to know that a change does take place; and what its results are, in regard to health.

Nature of the Air.—I must not pass over this part of my subject, without mention-

ing the changes which take place in the air which, in the lungs, comes in such close contact with the blood. This air, in its natural and most fit state for breathing, consists of about 80 parts of nitrogen gas, and 20 of oxygen gas, or vital air;* though some say there is always a little carbonic acid gas mixed with it, even in its purest or healthiest state. But no sooner is it breathed over in the lungs, even once, than the oxygen is greatly diminished, and the carbonic acid greatly increased. If we breathe the same air over two, three or more times, the carbonic acid becomes still more abundant, while the oxygen as rapidly diminishes.

Breathing Air twice.—If we breathe air twice over, or if we breathe that which already has carbonic acid in it, derived from some other source, it does not sufficiently

* Oxygen gas is called vital air, because without it, no life, or *vitality*, either of animals or vegetables, can be supported. And yet, if breathed in a much greater proportion than 20 parts in 100, it hurries life on, and soon destroys it; just as food and drink which stimulate us too much hurry us on too fast, and in that way actually shorten our lives.

change the blood from its black to its scarlet color. It is consequently sent back to the heart, and distributed all over the body, in a state totally unfit for the purposes for which the great Creator designed and gave it; and if this abuse is long permitted, the health suffers. Instances of this sort are quite common in crowded school houses, work houses, prisons, &c.

The air is changed, by breathing it, at a most astonishing rate. Probably we inhale—I speak now of adults, for children inhale proportionally less—about fifty hogsheads in twenty-four hours, or more than two gallons a minute.

It is proper to consider air which has been once breathed, as unfit for further respiration, or spoiled. Admitting this to be the case, we spoil the air for the purposes of breathing, at the rate of more than a gallon a minute. So, in fact, Dr. Franklin used to say, fifty years ago; and so, at the present time, say all the philosophers and physiologists.

Ventilation.—Now if these things are so, how careful ought we to be, not to have our rooms, in which we sit or sleep, too tight, or

too long closed. What pains ought we to take to *ventilate* (purify) them often, by opening the doors or the windows. This is the more necessary where there are no fires; for a fire helps to ventilate a room, by causing a draught of air from all directions towards the chimney; though in rooms without chimneys, fires are rather dangerous, since they increase more rapidly the carbonic acid, and other poisonous gases. You have probably read, in the newspapers, numerous accounts of people being found dead in rooms which were tight, where they had been burning charcoal.

How dangerous it must be to crowd school rooms, concert rooms, theatres, churches, &c., as we are apt to do, and to sit for a long time in them, without proper ventilation. How easy is it to raise a window, or open a door And though we might thus expose an individual, here and there, to take cold, how much more is he exposed to injury, by sitting in and breathing the bad air.

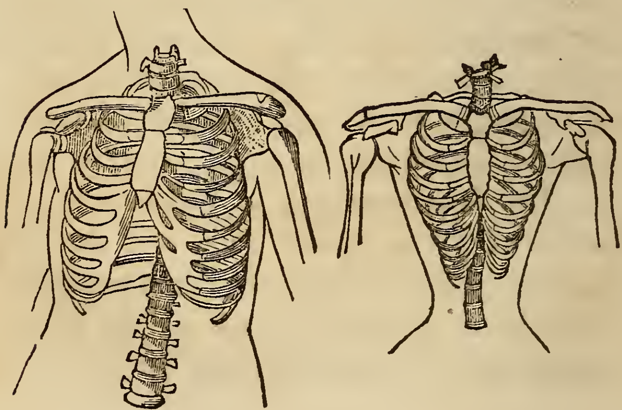
Free Motion of the Lungs.—Not only should the air be good in quality, but the lungs should have free play in inhaling it

From youth to maturity, we should follow no employment which, for any considerable time, will cramp or confine their motion. Neither should we sit or stand too long in a bad position, as young people are apt to do, in schools and factories. Nor should our dress be so tight as to press against any part of the chest.

Tight Lacing.—Health is always injured by every kind of lacing, as well as by stays, braces, corsets, tight vests, &c. We are not only more exposed to colds, pleurisies, fevers and consumptions, but also to diseases and bad formations of the very bones themselves—the breast bone, the spine and the ribs. I say again, therefore, beware of anything tight about the chest. The Prussian physicians recommend people to wear no cravat or stock, and to leave their bosoms unbuttoned and bare; and no people in the same climate, and under similar circumstances in other respects, are more free from consumptions and all sorts of diseases of the lungs, than those who observe this rule. But I do not know that the custom would be as favorable to all people, in all climates, as it is to the Prussians

It is very strange that so many people—and some too who think themselves very wise teachers—should still hold to the idea that moderately tight lacing of the lungs strengthens them. Mrs. Phelps, in her "Lectures to Young Ladies," inculcates this erroneous idea, and so do a few other writers. It is greatly to be hoped that the world will very soon get wiser on this subject. Few of those who restrain the chest have as handsome forms as the natives of Turkey, Georgia, Circassia, Otaheite, &c., where the females are never known to restrain motion by any sort of dress.

In closing this chapter, I will show you a picture of the bones of two human chests,



which have been accurately copied from nature, one of which is in its perfect state, and the other has been injured by tight lacing. I need not remind you which of them has been injured by the pressure of stays;—its narrow, contracted lower part will at once show you.

I ought also to remark, that this picture, according to the statement of Dr. Comstock, by no means exaggerates the evil effects of tight lacing. He says, "it is not nearly so great as we believe actually takes place in many instances of tight lacing;" and I believe so too.

If what I have said here on the nature and structure of the chest, should lead any person to study the structure of these important organs, the lungs, not only in this work, but in our larger treatises on Anatomy and Physiology, he will find himself most amply repaid for his labor, and will forever look back with satisfaction to the day in which his attention was arrested and his mind drawn to the subject.

CHAPTER XVII.

TEMPERATURE OF APARTMENTS.

Remarks on temperature. Curious question. Variations of temperature considered.

Few if any ordinary buildings, whether dwellings, shops or factories, are so constructed as to preserve exactly the same temperature in every apartment, and at all seasons of the year. And as for *heating themselves*, and preserving a uniform temperature, by the very employments or manufactures which are going on within them, nobody probably ever heard of such a thing. A self-heating house! Why, it would excite as much astonishment as would a machine which should really have the power of perpetual motion.

And yet the house I live in has this power, wonderful as it is, of not only heating itself by the process of generating and purifying blood, concerning which I have treated at length, and

by other curious processes, but also of regulating that heat, and keeping it at the same point, with scarcely any perceptible variation.

The heat of the human body is never far from 98° of Fahrenheit's thermometer. By this we mean, that if you were to plunge the bulb of the thermometer, containing the mercury or quicksilver, into the flesh of the body, or even hold it in your mouth, the mercury would rise in the tube till it got to about 98°, and there remain.

Now why does this heat continue nearly the same at all times, and in all places? If you were to take a piece of wood or iron, about the size and shape of a man, heated to 98°, and set it up in Greenland or Lapland, where it is so cold that the mercury would sink to 20° below zero, in the open air, do you think this iron would remain heated to 98°? Would not the air soon cool it down to about 20° below zero? How would it be with a man of wood or straw? How even with the body of a *dead* man?

Does any one suppose that the body of a *dead* man, heated about as hot as that of a living man, and put out in the open air of

Greenland, would remain warm very long? Then why should the *living* body of a man? Why does not the cold air rob it of its spare heat, just as it would a mass of straw or iron? Yet the daily experience of our lives proves that it does not.

The skin, and the outside of the hands, face, &c., may be cold, and sometimes even *frozen*, while the blood and flesh will generally remain about as warm as ever, unless the individual actually *freezes to death*. In that case, the heat escapes very rapidly; and hence the dead, as you know, quickly become cold.

Curious Question.—But why the heat does not escape from everybody, in ordinary circumstances, so that they freeze to death, is the point in question. You will not suppose there is a fire somewhere inside of us, which keeps up the heat; for if so, what supplies the fuel? Who ever knew of any wood or coal being used for the purpose? *Spirits* will burn, it is true; but those people who pour enough of this into their bodies to make quite a large fire, are no warmer than other

people: nay, they are even colder; for the blood of the dram drinker is a *little* colder than the blood of the man who drinks nothing but pure water.

When we think of all this, and remember that people can live very comfortably in climates like those of Labrador, Greenland, Norway, Lapland and Siberia, where everything around them—air, water, earth, stones, &c.—is cooled down to less than half the heat of the human body, for almost all the year, and to many degrees below the freezing point, a part of the time, is it not a great wonder that all our bones, and flesh, and blood, can keep at a temperature of 98°, or nearly that, not only for an hour or a day, but throughout the whole of a long life?

It is indeed almost a miracle; or would be thought so, if we thought anything about it. It shows, at least, how wonderful *life* is. For not only man, but all living animals, have this same power. Birds have even a higher degree of heat than man. The blood of some of them rises to a temperature of about 108°. If it were not so, they would often freeze to death in the cold season.

Living trees and shrubs, plants and seeds, have this same power of resisting cold, though in a less degree than animals have. Trees do not often freeze very hard. Were it not for this provision of the great Creator, everything would perish in the winter; and we should have no beautiful trees and green fields in the spring, as seeds and roots would perish in the ground. Besides, if spring, with its verdure, should return, there would be no men and other animals alive to enjoy it.

But we not only have this wonderful power of resisting cold; we are also equally able to resist extreme heat. By long practice, men have become able to remain in ovens and other places, heated to 220°, and even 270° of Fahrenheit, for ten or twelve minutes at a time. The only serious inconvenience which arises in such cases is a profuse perspiration.*

* Perspiration always modifies the heat of the human body more or less, and is one means of keeping us cool. The reason is, that the moisture on the surface of our bodies evaporates; and this produces cold. It is said that you may almost freeze a man in midsummer, by keeping him wet with ether; so rapidly does the ether evaporate.

But a piece of flesh without life would, in ten minutes, in such a heat, be thoroughly baked. Water boils, as you know, at 212°.

VARIATIONS OF TEMPERATURE.—Infants, except when just born, have a temperature of only about 94°. The heat increases, as we advance towards maturity, after which it remains nearly stationary at about 98°, until we begin to decline, when it slightly diminishes. In the spring and the beginning of summer, it increases a little, in persons of every age; but declines again towards winter. When a person is greatly enfeebled by sickness or otherwise, it is slightly diminished. In fevers and inflammatory diseases, it sometimes increases to 104°, and even to 107°.

But I have not yet told you *how* this steady temperature of 98° is kept up in the human system, notwithstanding the extremes of heat and cold. Indeed I cannot do it; for I do not know the cause. I have already told you that the evaporation of the matter of perspiration on our skins has some effect in keeping us cool; but this cannot be the sole cause why men can remain with impunity in places

heated to a greater temperature than boiling heat. There must be other causes, not yet fully understood.

As to the reason why we retain so high a degree of heat as 98°, when the temperature of the atmosphere is almost always far below that, there have been a great many speculations—guesses—by philosophers; but they have, generally, been *mere* guesses. The process of digestion, the formation of chyle, the change of chyle into blood, and the change of the blood in the lungs—especially the latter—are all believed to have a part in the work. Yet they do not, by their united efforts, accomplish one half of it; and it remains for future anatomists and physiologists to investigate the subject more deeply. Some suppose that electricity, or galvanism, or perhaps an agent much more subtle still, has something to do in the matter.

How far the laws of the great Creator may ultimately be discovered, in this, as well as in a thousand other things of which we are yet ignorant, it is not easy for us, in the present infancy of human knowledge, to conjecture.

DIFFICULT TERMS EXPLAINED.

Abdomen, the lower part of the body, containing the stomach, intestines, &c.
Absorb, to imbibe or suck up.
Absorbent, a vessel which absorbs or sucks up.
Acetabulum, a deep socket of the hip joint.
Alveolar process, the projection of the jaw which contains the sockets of the teeth.
Anatomy, the study of the human body.
Aqueous, watery.
Artery, a whitish pipe, which carries blood from the heart out into all parts of the human system.
Atlas, the upper vertebra of the neck.
Auditory nerve, the nerve of the ear.
Auricle, a part of the heart.
Biceps, a muscle situated on the upper part of the arm.
Bile, a liquor secreted or formed by the liver.
Capillary, very small; hair sized.
Capsular, hollow, like a chest or box.
Cardiac, belonging to the heart.
Carotid, the name of an artery of the neck, which carries blood to the head.
Carpus, the bones of the wrist.
Cartilage, a hard, gristly substance, covering the ends

of some of the bones to prevent their wearing too much.

Cataract, a disease of the crystalline lens of the eye.

Caul, the omentum. (See omentum.)

Cellular, abounding in cells.

Cerebellum, the lower and smaller part of the brain.

Cerebrum, the upper and larger portion of the brain.

Cerumen, the ear-wax.

Choroides, one of the coats or coverings of the eye.

Chyle, the white milky fluid formed from chyme.

Chyme, a grayish pulp into which food is changed in the stomach and intestines.

Clavicle, the collar bone.

Cochlea, a part of the internal ear.

Cœcum, a portion of the large intestine.

Coagulate, to thicken; to become curdled.

Colon, a part of the large intestine.

Cornea, that part of one of the coverings of the eye which is at the fore part, and is transparent, like the crystal of a watch.

Cranium, that part of the bones of the head containing the brains; the brain case.

Crystalline lens, a small internal portion of the eye.

Cuticle, the scarf skin; the outside layer of the skin.

Cutis vera, the thick or principal layer of the skin; the real skin.

Diaphragm, the thick, membranous floor of the lungs, separating them from the contents of the abdomen.

Duct, a pipe or canal.

Duodenum, that portion of the intestine that is next to the stomach.

Dura mater, the outside membrane or covering of the brain

Enamel, the very hard outside covering of the teeth.
Epiglottis, a little clapper or valve near the root of the tongue, to cover the top of the windpipe.
Fang, a root; the root of a tooth.
Femur, the thigh bone.
Fibre, a thread-like part of the human body.
Fibrous, consisting of fibres.
Fibrine, a thready substance, found in blood and lymph.
Fibula, one of the bones of the leg.
Follicle, a little hollow gland.
Gastric, relating to the stomach.
Gelatine, jelly.
Gland, a thick cluster or mass of blood-vessels, nerves, &c., appearing rather fleshy, as the salivary glands. The liver is but a very large gland.
Glottis, the narrow slit or opening at the top of the windpipe, covered by the epiglottis.
Humerus, the arm bone next to the shoulder.
Humor, moisture.
Hydrocephalus, dropsy of the brain.
Incus, one of the small bones of the internal ear.
Iris, a part of the eye.
Jejunum, the part of the intestines next beyond the duodenum.
Labyrinth, a part of the internal ear.
Lachrymal duct, a duct in the upper part of the eye.
Lacteals, absorbent vessels which carry the chyle.
Larynx, the upper part of the windpipe.
Ligament, a strong, white, flat cord, by means of which the bones are fastened together.
Liver, a large gland which secretes the bile.
Lungs, the organs of breathing.
Lymph, a colorless animal fluid.

Lymphatic, relating to the lymph.
Malleus, one of the small bones of the internal ear.
Mastication, the act of chewing.
Membrane, a thin substance like a very thin skin.
Mesentery, a membrane in the abdomen, to which the intestines are fastened.
Metacarpus, the bones of the palm of the hand.
Midriff, the diaphragm.
Mucous, forming or secreting a slimy substance.
Muscle, a bundle of lean flesh; the instrument of bodily motion.
Muscular, composed of muscles.
Myology, the study of the muscles.
Nerve, a prolongation or branch from the brain.
Olfactory nerve, the nerve of smell.
Omentum, a fatty membrane attached to the stomach.
Optic nerve, the nerve which goes to the eye.
Organ, a part performing some office or function.
Ossify, to become bone.
Osteology, the study of the bones.
Os ethmoides, a part of the skull.
Os frontis, that part of the skull which forms the basis of the forehead.
Os hyoides, a small bone at the root of the tongue.
Os occipitalis, the back part of the skull.
Os orbiculare, a small bone of the internal ear.
Os temporis, a part of the skull near the ear.
Os sphenoides, a part of the bottom of the skull.
Ossa wormiana, small irregular bones sometimes found in the skull.
Palm, the hollow or concave central part of the hand.
Pancreas, the sweet bread, as it is usually called.
Parietal bone, a part of the skull.

Parotid, a salivary gland near the ear.

Patella, the knee pan.

Pelvis, the bones of the lower part of the body.

Periosteum, a tough membrane which covers the bones.

Perspiration, the vapor of the human body.

Physiology, the study of the living human body and its functions.

Pia mater, one of the coats of the brain.

Pigmentum nigrum, a black pigment or paint.

Plica polonica, a disease of the hair, common in Poland.

Portio dura, a branch of a nerve going to the face.

Portio mollis, the auditory nerve.

Pylorus, the part of the stomach which opens into the duodenum.

Radius, one of the bones of the arm below the elbow.

Rectum, a part of the human intestine.

Rete mucosum, the middle membrane of the skin; that in which the color is found.

Retina, the part of the optic nerve which is in the eye.

Sacrum, a strong bone of the lower part of the spine.

Saliva, the natural moisture of the mouth.

Scapula, the shoulder blade.

Sclerotica, one of the coats of the eye.

Sebaceous glands, small glands, containing a fatty or oily substance.

Secrete, to form or make from the blood.

Secretion, the act or function of secreting.

Serum, the watery part of the blood.

Sesamoid, small bones sometimes found in the joints of the thumb and largest toe, supposed to resemble the seeds of the sesamum, a plant.

Skeleton, a collection of the bones of the human body, fastened together.

Skull, the bones of the head.

Spine, the back bone.

Stapes, one of the bones of the ear.

Sternum, the breast bone.

Sympathetic nerve, a large and important nerve, not closely connected with the rest of the nervous system.

Synovia, a liquor prepared by nature to lubricate the joints.

Thoracic duct, a large duct in the human body.

Tibia, one of the bones of the leg.

Tendon, a whitish cord by which muscles are usually fastened to bones.

Tube, a hollow vessel or pipe.

Tunica, a coat, or covering, or shell.

Tunica arachnoides, a thin covering of the brain, which has been supposed to resemble, in its appearance, a spider's web.

Tympanum, the drum of the ear.

Ulna, one of the bones of the arm below the elbow.

Ureter, a pipe or tube going from the kidney to the bladder.

Vacuum, an empty space—a space in which not even air is found.

Valve, a thin membrane.

Vein, a vessel which brings back blood from any part of the body to the heart.

Venæ cavæ, two great veins, opening into the heart.

Ventricle, a part of the heart.

Vertebra, one of the short portions of which the spine or back bone is composed.

Vestibule, a part of the internal ear.

Vitreous, glassy, or resembling glass.

QUESTIONS

TO

"THE HOUSE I LIVE IN."

CHAPTER I.

WHAT is meant, in this book, by "the house I live in?" Is it an appropriate name? Why is it so?

Is the house I live in one of the largest houses in the world? What houses are larger? Is it one of the oldest houses known? What are older? Does it exceed all others in beauty? Is it more expensive than most others? Has it more apartments? What can you say of its occupants? What of its furniture? For what is it most remarkable? (p. 26.) What did David say was fearfully and wonderfully made? Why is the house I live in "wonderful?" (p. 19.)

CHAP. II.

WHAT part of the human body is meant by the framework of the house I live in? What may be considered as the pillars? How many of them are there? In how many divisions are these pillars? How many bones in each foot? What is the whole number of bones in the two lower limbs or pillars? Where do we find the sesamoid bones? Why are they called *sesamoid?*

Which is the longest bone in the human body? What is its shape at the place where it joins the body? Will you point out this part, in the engraving?

What number of bones in the leg, below the knee? What are their names? Which is the largest? Which of them is on the outside? What is the joint called by which they are united to the thigh bone above?

What is the name of the small bone at the fore part of the knee? What is its general shape? Is it connected by a joint to any other bone? Is it, or is it not, a very useful bone?

How many bones are there in each foot? How are they fastened together? Will these ligaments yield when we walk? What would be the consequence to us, if the foot consisted of but one solid bone?

If we compare the foot to a bridge, what may be considered as the abutments? What bones form the arch of the foot? Is the heel exactly under the leg? What is the object of this arched structure of the foot? How may the awkwardness and inconvenience of a flat foot be illustrated?

In how many ways is the foot arched? What will help to give us a clear idea of this double arched structure? Why does the foot, in its natural state, appear less arched than it really is? What is there in the structure of the feet of other animals besides man, which shows, in a peculiar manner, the wisdom of the great Creator?

What can you say, in general, of the bones of the instep, or ankle? Where are they found? How many of them? Are they larger or smaller than those of the wrist?

CHAP. III.

What is said of the internal structure of a common stick of timber? What simple experiment proves this? How do the timbers of the house I live in differ in this respect from wood?

Is there considerable variety in the shape of bones? What are the three principal varieties of shape?

What can you say, in particular, of the long bones? How do the other two sorts differ from them? Where are some of the bones cellular or spongy? What part of the bones is always the hardest? What is enamel?

What is contained in the hollow of long bones? What covers or envelops this marrow? What lines the cells of the spongy bones? What do these cells contain? Are the bones pierced obliquely by large holes? What are these holes for? What else is there in the bones, besides marrow and blood? What do all the bones of the body weigh when perfectly dry? When bones are burnt, what is it which is destroyed? What is it which remains? What are some of the uses of the bony framework?

In what condition are our bones when we are born? What is there between the various pieces of bone? Are the bones of the head separable like the rest? Is there life, then, in all the bones? What evidence of this is afforded when diseased parts are amputated?

How can it be proved that there are blood-vessels in our bones? Are there nerves also? What do we always find where we find nerves?

CHAP. IV.

What are meant by the *sills* of the house I live in? How many of them are there? Are they large and strong? Are they regular or irregular in their shape? What hard name is given in books to these bones?

Are these ossa innominata in one solid bone, in a child? What is the sacrum? What is the name of the bowl, or cup, which, by their union with the other bones, the last mentioned bones seem to form?

In what bone is there a hollow, like an egg-shell with the end broken off? What is the book name for this hollow? What bone has its round end fastened into this "hollow vinegar cup"? Is the head of

the thigh bone easily dislocated? What alone will dislocate this head?

What effect will temperance have on the cartilages which unite our bones? Is it of importance that these cartilages should be kept in a soft and pliable state? What must be done, both by the young and the old, to preserve them in this state? Will a course like this be useful to bones and cartilages both?

CHAP. V.

We sometimes speak of the *stories* of a house; what do we mean by it? How many stories in the house I live in?

What is the principal post, or main support of these two stories? Of how many separate pieces is the spine made up? What is the name given to these pieces? Which five are very large and strong? What can you say of the twelve vertebræ belonging to the second story of the building? To what do the seven upper vertebræ connect the second or upper story? Are these seven smaller than the rest? What do the vertebræ resemble, piled upon each other? Is the spine a highly-important part of the body?

What has each vertebra in its middle? Does this make a continuous channel through the whole spine? What is this hollow, or channel, filled with? Of what does it seem to be a branch? What curious contrivance is there at the top of the spinal column? Can you describe it? What is its use? What would be the effect of pressure on the spinal marrow? (See note, p. 49.)

Besides the main hollow or channel in the spine, are there not other holes at the side, between each two vertebræ? How many of these holes, in all, on the two sides of the spinal column? What pass out at these holes? Where do they go to? Do they divide and sub-divide, till they become very small? Are they in greatest numbers in the skin? What is

there between each two of the spinal vertebræ? What is the use of this substance? Is it very yielding and elastic, as well as very thick and strong? What fact does this explain, in regard to rope-dancers and tumblers? Are we shorter at night than we are in the morning? Why is it so? Why do people become shorter by age? If the spine becomes injured, can it be mended? If the spinal marrow is injured, what happens? Is the spine easily broken or dislocated? What if it were?

How many ribs are there? To what are they fastened behind? To what before? Which are called true ribs? Which false? What is their general resemblance, viewed externally? Which are longest, the upper or the lower ribs? Are there ever more or fewer than twelve ribs on each side?

What is the book name of the breast bone? Is it, from the first, in one piece? When does it become solidified into one? What may be called braces in the house I live in? How many of them? What are the two in front called? What bones do they seem to brace up, and keep separate? What do we call the two braces behind the shoulder? What do the collar bones, by their shape, most resemble? With what do the shoulder-blades connect at the fore part?

CHAP. VI.

What parts of a building do the arms, by their uses, most resemble? Can they be removed without wholly spoiling the building? In what particulars do the bones of the arms, generally, resemble those of the legs? What do you say of the bones between the shoulder and the elbow? What are the names of the two bones below the elbow? How are the ulna and radius connected to the humerus above? When the arm is extended and the thumb turned outward, which bone is the radius? Which of the armjoints is like a hinge? Which has a more free and

extended motion? How many bones does the wrist contain? Is there a pretty free motion here also? Is the arm as curious as the trunk of an elephant? Why, then, does it not, by its movements, excite equal surprise?

CHAP. VII.

What is the most wonderful part of the upper extremity? What are represented at page 60? Which is seen on the left, the hand or the foot? Do we look on the back side, or on the fore side of it? How many bones in the whole hand? How many of these in the wrist? How many in each finger? How many in the thumb? What name is given in books, to the bones of the wrist? What to the four bones of the palm of the hand? Is the hand arched like the foot? How many joints in the hand, besides those of the wrist? Which are hinge joints? What does Sir Charles Bell say about the Creator's design in the different length assigned to the different fingers? (p. 63).

What are some of the uses of this little member — the hand — to the farmer? What to the miller? — the baker? — the tailor? — the hatter? — the milliner? — the shoemaker? — the scholar? — the mariner? What can be done, in an extreme case, without the hand? For which should we be most grateful to God, the tongue, or the hand?

What may be considered as the cupola of the house I live in? At the top of what is it situated? At what part of it are the doors and windows of the house inserted?

Of how many pieces of bone does the cranium, or brain-case, consist? What are the seams called by which these are united? Which is the most important of the bones of the cranium? What is the shape of the os occipitis? What do the temporal bones resemble in their shape? Where are the parietal

bones? Where are the large spheroidal, and little ethmoid bones? Is the cranium filled with brain? How large is the brain, usually, in an adult?

How many bones on each side of the frame of the face? Are these united by sutures, like the bones of the cranium, or by joints which are movable? Does the lower jaw consist of more than one bone? What is one important use of the upper and lower jaws?

What do we see beautifully arranged around one of the doors of the cupola? What number of teeth form a complete set, in little children? What number in adults? At about what age do the first or milk teeth disappear? At what period of human life are there forty-eight teeth visible and invisible, in a person? Which of the adult teeth have more than one fang or root? How many kinds of adult teeth are there? How many of each kind? How are the teeth inserted in the jaw? Why does the face shorten, and why do the nose and chin approach each other, in old age? Have the teeth a basis of lime, like other bones?

What are all bones in the first place? What is the change of these lumps of jelly into bone usually called? With what is the bony part of the teeth covered or crested over?

Into how many parts are the teeth usually divided? Have the teeth blood in them? Have they feeling, and therefore nerves?

Will the teeth wear out? What will cause them to wear out sooner than is natural or necessary? Will they not last the longer for being reasonably used? Is there any connection between the teeth and the stomach? (See p. 79.) Ought the teeth to be kept clean? How should this be done?

How many bones in the deep cavity of the ear? Are they large or small? Will you describe the malleus? — the incus? — the os orbiculare? — the stapes or stirrup? Where are these bones situated with respect to the tympanum or drum of the ear?

What small bone is found near the root of the tongue? What letter does it resemble? What are some of its uses?

CHAP. VIII.

In connecting together the various parts of an ordinary building, what sort of *joints* are made? What joints in the human body have a slight resemblance to mortises and tenons? Where do we find most of the real hinge joints?

What is the most striking example of a ball and socket joint? Will you point out the various parts of this joint as seen in the engraving? What other joints of this kind besides that at the hip? From what is it said the first idea of a door hinge was derived? Can you give an account of the elbow joint? What number of joints is there in the whole human frame? How is the wisdom of the great Creator displayed in the formation of these joints?

How are joints held in their places? Are most of these very strong? How are they applied to the joints? Do they adhere to the joints themselves? Are they remarkable for their smoothness on their insides? Are some of them very wide? Do some of them invest the joint completely, as with a sack?

What are these sack-like ligaments usually called? Are they numerous in the human body? What is their first use? What their second? What illustration of this second use do you find at the top of page 93?

What prevents the joints from wearing out rapidly? Could iron or steel be substituted for the present arrangement of our systems? What can you say about synovia? What will render this liquid just such as it should be? What will be the effects of having it too thick, or too thin? What may cause a grating sensation in the joints? Are the ligaments aided, in the performance of their office, by the tendons?

What effect has wrestling sometimes had on the joints? What is said of some old wrestlers? Does wrestling ever cause gout and rheumatism? Does it not at least always aggravate these painful diseases?

CHAP. IX.

Is it not important, in the progress of our studies, to review often?

What number of bones constitute the cranium, or brain-pan? How many make up the framework of the face? How many is a complete set of teeth? How many bones in the ears, and at the root of the tongue? What number, then, in the whole head, above the neck? What number in the spine? What number between the basis of the spine and the lower extremities? What number of the ribs, including also the breast bone? What, then, is the whole number of the bones of the trunk? What number in both upper extremities? What in each lower extremity? Now what number — sesamoid bones excepted — in the whole body? How many sesamoid bones are sometimes found? Adding these, what is the whole number of the bones in the body? How large are the sesamoid bones? What are the ossa *wormiana?* What is found in the substance of the brain itself? What is the condition of the bones in young children? What is found in gouty persons? Are there not instances in which various parts of the body, not intended to become bony, change into bone, or become ossified?

What do we usually mean by a skeleton? What is *sometimes* meant? What does the study of anatomy include? What is physiology? What did David, the king, say? Did he probably ever see a skeleton? Why not? What did they first dissect, in order to learn about the body? In what circumstances is it deemed proper to dissect human bodies now?

What is ivory? What is shell? What animals seem to have their bones on the outside of them? What is horn? What is one principal part of all the shells, bones, &c., of animals? What is one modern use of bones in Europe? Have bones been much used as manures in our own country? Why not?

CHAP. X.

WHAT is the line of beauty in the mineral kingdom? What in the animal and vegetable world? What is, then, the line of beauty in the house I live in?

Is the periosteum an exemplification of the last named principle? What, then, is the periosteum? What are its uses? What covering is placed over the periosteum? Which of these is it — the muscles or the tendons — that give roundness to the human form? On what are a large proportion of them situated? Where are the long bones usually smallest? Where are the muscles usually largest? Is the upper arm a striking example of this?

But what *is* muscle? What color are muscles? What gives them their color? In what vessels is this coloring matter contained? How do we know this? Are the muscles fastened directly at their ends to the bones?

What do muscles usually terminate in? What is the nature, &c., of these straps? What are they sometimes called, when boiled?

What is the internal structure of muscles? Can you discern this structure in a piece of boiled lean meat or muscle? Can the muscles, with care, be parted out? What is cellular membrane? What is its use, when found among the muscles?

How many muscles do we find in the human body? What is the engraving on page 116 designed to illustrate?

What anecdote is related at page 117, to show the nature of muscular action? Is it in point? If muscles shrink or shorten, what must be the certain effect? Will muscles shrink as much as wetted ropes? Is the shrinking or contracting of a muscle illustrated still further by the engraving on page 120? Please to make the experiment on page 121, in your own person. Why are the muscles fastened by their tendons so near the joints? When a part is

once shortened by muscular contraction, how does it get back again to its original position?

What soft substance does the cellular membrane which is on and between the muscles always contain, in a greater or less quantity? What is the effect when a large quantity of this substance accumulates?

Could we move so much as a finger without muscles? Should we not be more miserable than the brutes, without them? What reflections on this subject are suggested by the remarks on page 126?

CHAP. XI.

In general, of what does the covering of the house I live in consist? Into how many layers or membranes may the skin be subdivided? What does the skin in some respects resemble? Of what is it in reality composed? When is this structure most readily discovered? What other evidence have we that the skin is made up, very largely, of nerves? From which layer of the skin is leather made? What vegetable principle must, for this purpose, be made to combine with the gelatine of the skin?

In what does the color of the human skin consist? Is the third or inmost membrane of the skin the same, even in color, among all the nations of the earth? Is there not much ignorance abroad on this subject? Do we know some of the uses of the coloring matter of the skin? Will you name one or two of them? Does this coloring matter sometimes change in a person? Are there not examples of Africans and Indians turning white? Has this phenomenon ever been fully accounted for? Is it generally thought to be a species of disease?

What is the outer membrane, which goes to form the skin, usually called? With what will this compare, in the covering of a building, say of wood? What do they say who have viewed it through a microscope of high magnifying power? Is this the part which

rises when the skin is said to be blistered? Is it usually as thick as it is in the case of a blister? Is the cuticle equally thick on all parts of the body? How do we get the best idea of this membrane? What is the most surprising fact concerning it? Can the coloring matter of the second or middle layer be renewed, like the cuticle? Can the true skin? What are scars?

Do most or all animals require oiling? What provision is made for this purpose in some other animals? What in man? Where are these oily or sebaceous glands most numerous in man? Is it necessary for man to put additional oil on the surface of his body? May this oil ever prove a source of disease?

What are some of the openings of the skin called? How many have been reckoned, in former times, to a square inch? What is perspiration? What is sweat? Do we always perspire?

What may follow from checking the perspiration unduly? How may this result happen? Is there not great neglect among us, on this subject?

What can you say of the hair and nails? Does the hair ever become diseased? What causes plica polonica? What is the use of the nails? Why do the ends of the fingers sometimes become curved?

CHAP. XII.

What parts of the human body may be said to be the windows of the soul? In what respects are they superior to other windows?

What is the shape of the human eye? What its size? How is it situated? Is it or is it not immovable? On what is it placed? By what is it fastened? What is the object of the engraving at page 142?

How many muscles of the human eye? How are the straight muscles situated? How is the eye moved sideways, or upwards, or downwards? When

all the straight muscles act together, what is done to the eye?

Is the eye a hollow sack? What does this hollow contain? Is the covering of the eye simple or complicated? What is the outer coat called? Can you describe it? What is the cornea? How is it set in the sclerotica? What do we mean by the "white of the eye"? What is the choroides? What is the black pigment? What is the use of this pigment? What is the iris? What determines the color of the eye? What is the pupil of the eye? What makes it larger or smaller, at different times? What is it in the eye which resembles melted glass? In what part of the eye is the aqueous humor? In what part the vitreous humor? Where is the crystalline lens situated? What does it resemble? How large is it? In what disease of the eye does the crystalline lens turn whitish? Can this disease be cured? In what way?

Where is the optic nerve situated? Over which coat of the eye is it spread? What is the retina? Through what do the rays of light pass, in order to reach the retina? Is the image of an object painted on the retina bottom upwards? When are we said to be near-sighted? When long-sighted? What is the use of glasses for the eyes?

What are tears? How are they furnished? How is the eye kept moist and clean? Will you describe the lachrymal duct? What follows when this duct is obstructed?

What is the intention of the eyelids? What would happen if they were removed? Is it well to expose the eyes to the full blaze of a lamp or fire? How are the eyes frequently injured?

What is the use of the eyebrows and eyelashes? May they not have other uses besides these, which are at present unknown to us?

CHAP. XIII.

What are some of the doors to the house I live in? Is the ear one of these? Is the human ear in two great divisions? What are they? What is meant by the external ear? What is said of its curious structure? What can you say of the lining of the ear? What is said of ear wax? How is deafness sometimes produced? For what purpose do some suppose the ear wax was made bitter? How far is it to the drum, or tympanum, which separates the external from the internal ear? What is said of the importance of cleanliness of the ear? What do we find, beyond the tympanum, in the internal ear? Is there a passage-way from the back part of the mouth, near the nostrils, to the ear? For what purpose is this passage? Into what does the tympanum open near the hinder part? What part of the ear is called the labyrinth? What is the vestibule? What are the semicircular canals? What the cochlea? What is deemed most striking in regard to the human ear? (p. 162.) Is there not a good deal of wisdom displayed in the structure of the ears of many other animals besides man?

What is the great purpose of the nose? Is the internal surface of the nose — or what we may call the internal nose — very extensive? Does it communicate with the cavities? Where are some of these cavities situated? What nerve has numerous branches spread over these cavities? Is the sense of smell more perfect at first than it is in later life? Why this result? Has the nose any connection with the voice, as in speaking and singing? Is the nose ever converted into a chimney? What are the effects of so doing on its lining membranes?

Which is, after all, the most important door to the house I live in? Can there be any thing else substituted for the mouth? What anecdote is related on page 166?

CHAP. XIV.

ARE there apartments to the house the soul lives in? Have some of these apartments doors to them? Are there many empty or vacant apartments? What sort of cavities or apartments of the human body are lined? What is the name given to the membrane which lines these parts?

Is the cavity or apartment of the external ear so small as hardly to be worth our notice?

What are some of the apartments or cavities of the nose? What is a polypus? What is sometimes mistaken for genuine toothache? Can we, in this way, account for one troublesome disease among sheep? Will the same reasoning also satisfy us why pain is felt over our eyes in case of a cold? Are smelling bottles to be avoided? Is not snuff also injurious? And also the smoke of tobacco?

Is the internal mouth one apartment of the house I live in? What furniture do we find in this apartment? Does it communicate with numerous other apartments? By what particular arrangement?

Are there chambers of much size in the salivary glands? Are they at all regular in their shape? Will you describe them — small as they are — very briefly?

Is it easy to describe all the little chambers or cavities connected with the mouth, nose, ear, &c.? What is there which can be compared with a trap-door? What room does this trap-door shut up? What does it exclude?

Is the cavity of the chest very large? Does it nearly fill the upper story of the house? How is it bounded? What is the membrane called which separates it from the cavity of the abdomen?

What can be said, in a general way, of the cavity of the lungs? Where does it begin? How does it terminate? What comparisons, on pages 177 and 178, serve to show us the shape of these curious apartments?

Is there in the throat a kind of music box? Of

how many pieces of cartilage is it made up? Contiguous to what other organs is it? Upon what depends the tone of the voice, in speaking and singing? What is the book name of the trap-door, elsewhere mentioned?

May the food-pipe be considered as an apartment of the human house? Has it much regularity of shape? In which story is it situated? When does it expand into a spacious saloon?

What is the name given to this saloon? What is its shape? What is its entrance or hall called? What its outlet? How much will the stomach of an adult hold, when moderately stretched?

What are some of the principal items of furniture in the abdominal apartment of the human body? What is the length of these intestines? In how many divisions are they usually regarded? Where does the first division of the small intestines begin? What three names are applied to as many parts of this same division? What to the various parts of the second division? What is called the appendage of the cœcum? What is the transverse arch of the colon? What is the omentum or caul? With what are the glands of the mesentery connected?

To what cavity is there an entrance just beyond the stomach? How large is the gall bladder? Is the pancreas or sweetbread in the same region with the liver and gall bladder?

Is the apartment of the circulation a large apartment? How many quarts of blood will it hold, in the case of an adult? How can it be ascertained that its capacity is so great? Can you give a more particular account of the circulation? How many cavities are there in the heart? How many auricles, and how many ventricles? How great is the capacity of these cavities? What is the general size of the adult heart?

In what part of the hollow cranium do we find the brains? What are their color and appearance? In how many great divisions is the brain? What is the name of the largest of these? What is that of the

smallest? What is meant by the hemispheres of the brain? What is between the two hemispheres? What is the name of the outside covering of the brain? What of the second covering? What of the third or innermost? What is the color of the brain on its outside? What on the inside? From which part do the nerves or branches of the brain proceed? How many times larger is the cerebrum than the cerebellum? What name is given to some of the deep and large cavities of the brain? How many are there of these deep cavities or ventricles? What is the nature of the disease called *hydrocephalus?* After all, is it true that there are any real cavities in the human body?

From what part of the brain do the nerves proceed? How many pairs go from the brain? What is the name of the first pair? What is that of the second? To what parts do the third pair go? To what the fourth? Which pair is divided into three great branches? To what parts are they distributed? Where are the branches of the sixth pair of nerves sent? What are the uses of the *portio mollis* and the *portio dura?* What is said of the eighth pair? What of the ninth? What of the great sympathetic nerve? How many are there of the spinal nerves? Do these proceed, as branches, from the spinal marrow? Through what holes or openings do they pass? What is one important difference between nerves and blood-vessels?

CHAP. XV.

What is one striking difference between the house I live in and an ordinary dwelling of wood or stone? Are there rivers in the human body? Rivers of what? Is the preparation of blood a curious process?

What is the chief office of the teeth? What aids them in the performance of that office? Can you

describe the process of deglutition or swallowing? Why does not the food, in swallowing, fall into the windpipe?

What is the immediate effect of having a hard substance fall into the windpipe? What are some of the remote and more serious effects? What case is related, from the Boston Medical and Surgical Journal? What important caution is suggested on page 206? What is sometimes the consequence of swallowing too rapidly? What is a surgeon occasionally called on to do?

What is the first change which food undergoes in the stomach? What happens after it is softened? What, then, is chyme? What is the object of the gastric juice? How is the gastric juice formed? What can you say of secretion? Will you describe the pylorus? What impedes the passage of chyme through the pylorus?

What liquid is added to the chyme, soon after it leaves the stomach? Where is the bile formed? What are some of its properties? What is one use of the pancreas or sweetbread? In what part of the body are these organs found? After these liquors are mixed with the chyme, what becomes of it? In what part of the small intestines is chyle found in greatest abundance?

What are lacteals? Where do they originate? What do they contain? Are they not sometimes called absorbents? Into what duct is the chyle conveyed? What is the color of chyle? What is said about this at page 211? How large is the thoracic duct? At what part of the body is the chyle poured into the veins, and mixed with the blood? Where is this mixture of chyle and blood sent immediately afterward?

What other numerous set of vessels unite with the main circulatory system? (See top of p. 211.) In what part of the body are they most numerous? Are they very small? How can they be seen? What is the office of these vessels? What is the name of the liquid they contain? What is its color? What other

name, besides absorbents, is sometimes given to these vessels? What are found swimming in the chyle? How do they differ from the globules in the blood? What name is given to the whole process of changing food into blood, so that it can nourish and support the body?

Is heat given out in the work of digestion? Can we digest both animal and vegetable food? What substances make the best chyle and blood, in the case of adults? What, in the case of infants? Will spirits make any chyle?

If we open a vein with a lancet, what will flow out of it? When this liquid stands a while, what change takes place? What is the watery part of the mass denominated? What is fibrine? What does the coloring matter of blood consist of? How much iron is there said to be in the blood of an adult? What else do the chemists find in the blood besides phosphate of iron? In what do we find albumen except in the blood?

What is meant, in this book, by *secretion?* Will you name some of the fluids in the body which are properly called secretions? What important class of organs, in the body, aid greatly in the work of secretion? Of what is a gland made up? What large gland has its vessels represented on page 218? Name some of the other large glands of the human body. What are sometimes called *kernels?* From what are all the secretions of the human body made up? Are not all the liquids of the body made too from blood. Are the solids, as well as the fluids, formed from the blood? Can you describe, briefly, the process? What is said by Dr. Edwards? Is there, then, continual waste going on in the human system? How is this waste repaired?

Is the heart in almost continual motion? Is the heart double? Do the two parts communicate with each other? Where is the heart's motion felt externally? What is the real position of the heart? Can you explain the motion of the heart, as represented

on page 226? Do the cavities of both sides of the heart fill in the same instant? Do both auricles contract at the same time? Is it the same with both ventricles? How can the blood in the veins go up hill? How often does the heart beat, in the case of an adult? In whom does it beat most frequently? What is pulse? Where can the pulse be felt?

Is the force of the heart considerable? How great do some reckon it? How little is it reckoned by others? What is, probably, near the truth? What anatomical mistake has been the cause of much error on this subject?

What are capillaries? What did Dr. Smith believe concerning their use? Have the capillaries ever been compared to pumps? What is the probable truth concerning them? Will you read the extract from an English magazine, at page 235?

CHAP. XVI.

Does the blood, in the course of its circulation, become gradually impure? How is it purified? How can the air come in close contact with the blood? Is air found in almost every part of the body?

May the lungs themselves be compared to a bellows? How many times in a minute does this bellows blow? Is it the same with children as with adults? Over how large a surface does the internal, or lining membrane of the lungs extend?

What is the capacity of the lungs, in cubic inches? How many quarts, or quarts and pints, would this be? Do we expel all the air from our lungs at a single respiration?

But how is the process of breathing performed? What bones are concerned in the process? What do we find between the ribs, which are concerned in the work of respiration or breathing? How many mus-

cles aid more or less in this great work? Does the heart beat faster in proportion to the increased action of the lungs?

Of what principles, chemically, is the blood composed? Are the proportions of these principles changed, while air is in the lungs? How is the blood so changed as to become black blood? How is its dark color removed?

Of what is the atmosphere composed? Which of these principles or gases is used up — or at least disappears — in the lungs? What is formed in its place?

Should the air ever be breathed twice? Should we breathe air which has in it carbonic acid? What would be the consequence of breathing too much oxygen? (See p. 246.) How much air do we probably inhale at a time? (See p. 241.) How much in twenty-four hours? Do not children use less than adults? How much do we completely spoil in a minute?

If these things are so, what ought to be done to our rooms? Do fires aid the work of ventilation? What do we often read in the newspapers? Is it dangerous to remain too long in crowded rooms?

Should we live much in the open air? Should we be careful in the choice of our employments? Should we avoid too long sitting? Is tight dressing injurious?

What are some of the consequences of tight lacing? What do the Prussian physicians think? Into what error has Mrs. Phelps fallen? What does Dr. Comstock say on this subject?

CHAP. XVII.

Has the house I live in the power of warming itself? What is the ordinary heat of the human body? Why does a dead man freeze sooner than a

living one? When may it be said that the fire within us goes quite out?

Is the process by which we are kept heated to 98° almost a miracle? Are there not some animals whose blood is hotter than that of man? Do trees have an internal power to generate heat? Can man's body resist heat, as well as generate it? Is our heat as great when we are first born as it is afterward? Is there much of physiology which is yet involved in mystery?